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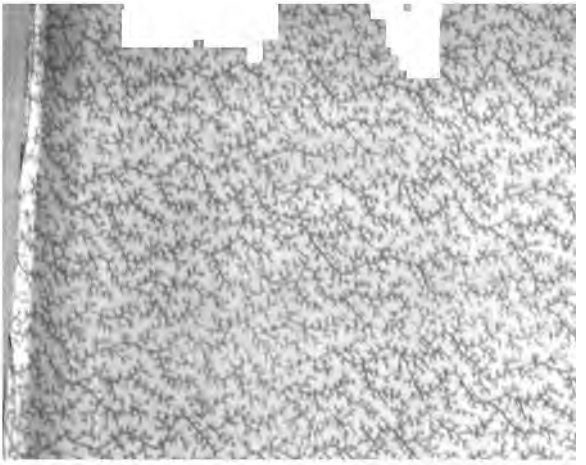

Phillips
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THE

Universal Preceptor,

BEING A GENERAL

GRAMMAR

OF

ARTS, SCIENCES,

AND

USEFUL KNOWLEDGE,

With Six Hundred Questions and Exercises.

BY THE REV. DAVID BLAIR;

Author of the Class-Book, English Grammar, Models of Juvenile Letters, Reading Exercises, and Grammar of Natural and Experimental Philosophy.

THE TWELFTH EDITION, IMPROVED.

LONDON:

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PREFACE.

THE Author of this work has been many years anxious to achieve his present undertaking. His experience, reason, and feelings, prove to him, that, in the progress of education, Young Persons ought to be enabled to acquire, on all subjects, correct and well as general views, which may serve as food for the mind in after life, and become the basis of further studies in such branches of knowledge, as, at a future period, may gratify their tastes, or accord with their interests.

Early education cannot make adepts in any branch of science. Without sacrificing every other subject to one, it ought, therefore, to embrace the elements of general knowledge, as the true means of enlarging and exercising the understanding, and qualifying it to engage with advantage in a particular pursuit.

To fill the storehouse of the memory, the rational business of education; and, at a season of life, too, when the powers of reason have not acquired a useful degree of action. Nor will such general instructi

interfere with particular studies, if the tutor be provided with a Text-Book, embracing the foundations of human learning: such, it is presumed, will this volume be found.

When the Author compiled his CLASS-BOOK, he was actuated by similar principles; and he believes it is generally felt, that great advantages have accrued to young persons, from the perusal of that work.—Every tutor must be sensible, however, that the Class-Book, as a mean of enlarging the sphere of useful knowledge, is rather to be considered as a commentary, than as a key to the temple of Science itself. The CLASS-BOOK has its superior uses; but, through its medium, the building can only be viewed at a distance; the object, then, in the present work, is to lead the young student up the steps of the portico, to open the doors to him, and usher him into that temple where man is raised above his fellows, and placed in contact with the good and the illustrious of his species!

Without interfering with particular branches of education, all the parts of this work may be rendered familiar within two years: one paragraph may be committed to memory every day; and *The Book of Questions* may be answered twice over within that period. When this task has been finished, what an accession of varied know-

ledge will have fallen to the lot of the pupil! How stored will be his mind, with interesting ideas for contemplation and conversation! and how comparatively blank must be the minds of others, who have not enjoyed the same advantages!—Yet, particular studies, at the same time, need not be neglected! This book may, indeed, be collateral in labour; although it will prove primary in effect.—But the author may be said to be sanguine; he, therefore, forbears to say all to which his hopes prompt him; and leaves his book to speak for itself, and prove its worth, by its actual effects on the rising generation.

For the convenience of Tutors, A Key to the Questions, in *the six hundred Questions* appended to this work, has recently been published, including Answers to the Questions in Goldsmith's Grammar of Geography, in Barrow's Scripture Questions, Adair's English Questions, and ten other works. Such an auxiliary cannot fail to render the *Universal Preceptor*, and the other books on the same plan, particularly acceptable to all Tutors; as it will relieve them from much unnecessary trouble and anxiety.

D. B

THE

UNIVERSAL PRECEPTOR;

OR,

Grammar

OF

GENERAL KNOWLEDGE.

I. *Introductory Particulars.*

1. KNOWLEDGE is either necessary and useful, or ornamental and luxurious.

It distinguishes civilized from savage life. Its cultivation in youth promotes virtue, by creating habits of mental discipline; and by inculcating a sense of moral obligation.

Knowledge is, therefore, the best foundation of happiness.

2. *Necessary* KNOWLEDGE is that which simply provides man with food; and with the means of sustaining life.

3. *Useful* KNOWLEDGE is that which teaches the arts of agriculture, clothing, building, restoring health, preserving social order, maintaining national independence, and rendering the produce of all climates subservient to the wants of our own.

4. *Ornamental* KNOWLEDGE relates to subjects of taste; as drawing, painting, poetry, grammar, geometry, eloquence, history, music, dancing, dramatic representation, and the living languages.

5. *Literature* Knowledge includes abstract enquiries; as physics, metaphysics, many branches of experimental philosophy, heraldry, antiquities, and the dead languages.*

6. Man is an animal endowed with the powers of communication, memory, association, imitation, reflection, and reasoning; talents given him by his Maker; for the good use of which, he will be accountable in a future state.

7. In his unimproved and uncivilised condition, man is naked, without habitation, without means of defence or offence, and possessed of no means of subsistence, besides the wild fruits and spontaneous produce of the earth.

8. To this day, some nations live naked in caverns under ground, perform no labour, and depend for their subsistence on the spontaneous products of the earth, and on the flesh of animals, which they destroy by simple stratagems.

Observation—Such are some of the nations of Africa, the inhabitants of New Holland; the people of many of the South Sea Islands; the Greenlanders; the natives of Hudson's Bay; and some of the Siberian nations; of whom, very curious particulars will be found in books of voyages and travels, and in Goldsmith's popular system of Geography.†

9. Till the Romans invaded England, the Britons lived naked, chiefly under ground, painting their bodies of various colours, bestowing no cultivation on the soil, and depend-

* This division of knowledge is unavoidably imperfect; and is little respected in the details of this work.

† The observations are not to be committed to memory; but to be read by the pupil to the tutor, or by the pupil alone

ing for subsistence on acorns, berries, and roo
and upon their skill and success in hunting a
fishing.

Obs.—The people of Britain are indebted to thegr
ambition of Julius Cæsar for the introduction into th
islands of those arts of civilization, which had travel
from the Ganges into Persia, from Persia into Egypt, fr
Egypt to Greece, and from Greece into Italy; when
by the lust of conquest, they were spread over Euro
In like manner, at this day, and from the same cau
the English are the instruments of reflecting back
arts of civilization, amended by a true religion, to
banks of the Ganges; and of disseminating the sa
blessings among the Africans; the Americans; and
insulated people of the South Sea Islands.

10. The Romans introduced among the B
ons, all the arts and knowledge which they h
themselves received from the Greeks; and h
the foundation of that social state, in which
find ourselves in England, after the lapse
nearly two thousand years.

Obs.—To take a view of knowledge, as it has extend
itself from the most barbarous and uncultivated tim
down to this age of literature, science, and philosoph
and to render the whole plain and familiar to you
minds, and to the meanest capacities, are the objects
the present work.

II. *Of the Simple Arts of Savage Life.*

11. The arts of savage life are those whi
were possessed by the ancient Britons; a
which are witnessed at this day, among all b
barous people. They include the arts of swi
ming, hunting, taking aim with missile weapo
and procuring fire.

12. The art of swimming, depends, first, on keeping the arms and hands under the water; on protruding only the face and part of the head out of the water; and then using such action, as will direct the body in any particular course.

Obs. The inferior animals swim without instruction; because they are unable to lift their fore-legs over their heads. The secret of this art depends, then, on keeping down the hands and arms, and acting under the water with them. The parts of any body which rise out of the water, sink the parts that are immersed within it.

13. Hunting is performed by most savage nations on foot, and their only weapons are clubs. The swiftest of foot, and the strongest, usually become, therefore, Chiefs among such people.

Obs.—Hence, Hercules, the hero of antiquity, is drawn with no other weapon than a club; with which, alone, he is said to have performed all his wonderful exploits. Some nations, little removed above savages, are, however, found to have acquired the use of bows and arrows.

14. In taking aim with missile weapons, the precision which savage nations have attained, is wonderful. In throwing a stone, they seldom miss the smallest mark; they transfix fish in the water; knock down birds on the wing; and strike every enemy with unerring exactness.

Obs. Every one is acquainted with the success of the shepherd David, in killing Goliah. Even such is the precision of the South Sea islanders at the present day.

15. The greatest attainment of savage life, is the procuring of artificial fire; but this was an art not known to all barbarous people. The inhabitants of the Ladrones considered fire as an invisible monster, when the Spaniards first introduced it among them.

16. The Persians, and other eastern nations,

after they had once acquired, or obtained fire, made its preservation a religious duty; and fire was continued in their temples, without being once extinguished, for many hundred years Hence, they became, or were considered, fire-worshippers.

17. Among savages, the usual mode of producing fire, is, by the rapid friction of two pieces of wood till they produce flame. Having no metals, they do not possess the simple method of communicating a spark to tinder, by the violent collision of flint and steel.

18. The cloathing of savage nations has reference solely to the inclemency of the weather; and consists generally of the skins of animals, or of the natural products of vegetables, without preparation or the intervention of art.

19. A precarious mode of subsistence is so unfavourable to the human species, that, it is found, savage tribes, in a series of ages, do not increase their numbers: and that they often become altogether extinct.

20. In the back settlements of North America, the souls in the various half-starved savage tribes, do not exceed twenty thousand; while, on an equal space of country in China, two or three hundred millions, aided by the arts of civilization, are much better fed and provided for.

21. The wretched Indians who reside in the districts that surround Hudson's Bay, often pass a week together without food; and frequently die of want, during the chase of an ani-

mal, which they have pursued on foot for many days together.

Obs.—Hence, the origin of hospitality and social meetings kept up in civilized life, for purposes of pleasure; but originating in ages, when to divide with friends and neighbours the produce of the chase, was the first and the kindest of duties.

☞ If there are some privations to be borne in society; if the successful emulation of industry and talents, create great inequalities of enjoyment; and if the laws are abused, and sometimes bear oppressively on weak individuals, the worst condition of social and civilised man, is better than the best condition of the untutored savage.

Obs.—Such is man, in his native and original state, in all countries; and such are the boundaries of knowledge, among all aboriginal people: let us now consider him, in a better, in a happier, and a more respectable condition.

III. *Of Farming, or Agriculture.*

23. The first step, from savage towards civilized life, is the acquirement, protection, and recognition of property. In early ages, this consisted only of what was essential to the immediate wants of man.

24. The first property consisted of sheep, goats, and oxen; and the first husbandmen were the herds, who tended their flocks, and drove them without restriction from pasture to pasture.

Obs.—We have a beautiful picture of the pastoral life in the book of Genesis; Abraham, Isaac, Jacob, and their families, were shepherds or husbandmen of the east-

liest ages. It will be seen, that their wealth consisted in their flocks and their live stock; and that they roamed over the country to find pasture wheresoever they pleased.

25. In the pastoral ages of husbandry, there was no property in land; all the country, was open and common to any occupier; and no one assumed to himself a property in the soil, or considered as his own, the produce of any particular spot.

26. In Africa, among the native Americans, and in most parts of Asia, there exists to this day, no property in the land; hence, in those countries, it is but little cultivated; and subsistence is precarious; notwithstanding the fertility of the soil, and the general character of the climates.

27. The recognition and protection of property in the soil, are the bases of industry, plenty, and social improvement. This is, therefore, one of the most important steps in the progress of man, from the savage, to the civilized state.

28. As soon as any man could call a spot of ground his own, and could secure to his family the produce of it, he would carefully cultivate, sow, and plant it; knowing that he should reap the reward of his labour in the season of harvest.

29. Countries, however, in general, lie open; with nothing but banks and ditches to divide the land of every husbandman: but in England, each separate farm is divided from others, by hedges and fences; and the farms themselves are broken into small enclosures.

30. In France, Germany, Italy, Spain, an most other nations, the lands still remain u enclosed in large open fields; and those cou tries, in consequence, present a dreary appea ance to the eye of an Englishman; whose e closures render England the garden of t world.

31. Enclosures greatly improve the clima of a country, by protecting it from inclemen winds; they pleasantly subdivide the labou of the farmer; and, by restraining the exercis of cattle, they occasion them to get fat muc sooner.

32. Farmers are called *arable farmers*, whe they are chiefly employed in raising corn; an *pasture* or *grass-farmers*, when they are engage in rearing and fattening sheep, and other li stock.

33. Farms vary in size, from fifty to or thousand acres. Arable farms are general smaller than those employed in pasture, grazing. Those, from two to four hundre acres, are the most beneficial to the occupie and the public.

34. Soils are divided into clayey, loam chalky, sandy, gravelly, peaty, and moory. Th clayey and loamy are called stiff or strong soils and the sandy and gravelly, light soils.

35. Soils are barren, when they consist of to much of one kind of material, do not hold moi ture, or are too shallow. They are fertile, whe they contain a due mixture of several primitiv earths with vegetable and animal matter.

36. To render a barren soil fertile, it ought to be frequently turned up to the air, and to have mixed with it mixtures of animal dungs, decayed vegetables, lime, marl, sweepings of streets, &c.

37. In turning over the soil, the chief implements of the Gardener are the spade, the hoe, and the mattock; and those of the Farmer, are the plough, the harrow, the roller, the scythe, and the sickle.

38. As a succession of the same crop tends to impoverish the soil, a rotation of different crops is necessary. Potatoes, grain, and white crops, are exhausting; but, after them, the soil is ameliorated by tares, turnips, and green or plant crops.

39. On stiff soils, clover, beans, wheat, cabbages, and oats, may be cultivated in succession; and on light soils, potatoes, turnips, pease, oats, and barley, may succeed each other. The general rule is, one crop for man, and one for beast.

Obs.—This plan of varying the crops, is a new discovery. Formerly, land lay long in fallow; that is to say, was not worked every third or fourth year; but now, it is usual, by varying the crops, to get two, three, or four crops in a year from the same soil, without its being exhausted; and fallowing is, consequently, found to be unnecessary.—*See Young's Farmer's Kalendar.*

40. *Wheat* is sown in September or October; but the spring-wheat is sown in March. It ripens in August and September, when it is reaped, housed, and threshed. After being ground at the mill and sifted, wheat forms flour:

the flour mixed with water and yeast, ar in an oven, becomes *Bread*.

41. *Barley* is sown in April and M made into malt, by being heated to a germination, and then broken in a mill malt be infused in hot water, the infusi the addition of hops, may be fermen beer, ale, and porter.

42. *Oats* are sown in February or when ground, they form *oatmeal*, and mi water the meal becomes oat-bread; ground, they are favourable food for h

43. There are other species of grain c in England, as rye, peas, and beans. Th makes black bread; and the latter known as delicious and wholesome foo a very nutritive grain, is much culti warm climates; and there preferred kinds of grain for the food of man.

44. Modern husbandry has subdivid into nearly a hundred several kinds; o there are two principal divisions; grasses, and artificial grasses. The sev are sown and cultivated together, or sep according to the nature of the soil, or ject of the cultivator.

45. The natural grasses are very num their kinds; and are preferred for l tended to be kept in grass. The artificial are ray grass, red clover, trefoil, sanfoil tares, yarrow, turret, &c.

46. On many farms, cows are kept milk they yield: and for the purposes of

butter or cheese. Butter is made from cream by agitating it in a churn; and is the oily part of the cream, or a sort of a solid oil. Cheese is made from milk by curdling it with runnet; and the curd is then pressed, shaped, and dried.

Obs.—The runnet is prepared from the stomach of a calf; which, having been pickled for the purpose, is dried and afterwards infused in water for a few hours. The water, dissolving a kind of acid, is mixed with the milk, which it soon curdles. In commerce these stomachs are called *vells*. The cheese would be white, if the milk were not previously coloured with Spanish or other Arnetta. The largest cheese-farms are in Cheshire and Denbighshire; and on some of these, 500 milch cows are kept.

47. In England, of late years, selections have been made of breeds of cattle, sheep, &c. from among those which fatten the quickest, which have the best-flavoured flesh, best wool, &c.

48. Among oxen, the kinds that have been preferred, are the middle-horned, or Devonshire, for working; and the short-horned, the spotted, and the Alderney, for milking.

49. The long-horned, the Welch, the Kyeloe, and the Fifeshire, have also their separate purposes and recommendations.

49. Among the improved breeds of sheep, the favourite is the South Down; but the Tees-water, Dartmoor, and Romney-marsh-breeds, are the largest; the new Leicester and Lincoln are the next. The fleece of the Lincoln weighs 11lbs.

50. Those sheep which produce the finest wool, are the Merino, the Ryeland, and the Shetland: but their fleeces weigh only from 2 to 3lbs.

A male sheep is called a tup or ram; a
female, an ewe. They are usually shorn in
and are called one-shear, two-shear, or
shear sheep, according to their ages.

51. Horses are divided into blood-hor
racers; hackney or riding-horses; coach-
Cleveland-bays; Suffolk-punches; Clyde
and heavy blacks; each of them adapte
tinct purposes of use or pleasure.

52. Hogs are severally of Berkshire
shire, Shropshire, Gloucestershire,
white, and swing-tailed breeds; all dif
their shapes and character.

53. Numerous other productive an
also objects of the farmer's care; as
eggs; geese, ducks, turkeys, Guinea-
pigeons; bees for honey; and fish
ponds. Farmers likewise extract
apples; perry from pears; and delic
wines from various fruits.

54. Every farm-house is provid
kitchen-garden, for the cultivation
and fruits. The Art of Gardening
one of the most useful and delight
of rural employment. Besides kit
for raising vegetables, there are fi
orchards, flower-gardens, and ple
one part of the world, are propa
tivated in other climates, to whic
seemed to be ill-adapted.[a]

[a] In the present edition, the long pa
purposely broken, for the ease of ju
the numbers remain the same.

Thus, in England, our principal native fruits are, the whortleberry, the strawberry, the cranberry, various sorts of plums, hazle-nuts, the acorn, the blackberry, the alder-berry, hips, and haws; but we now have gooseberries, currants, apples, pears, superior plums, apricots, peaches, nectarines, and grapes—most of them exotics, and first cultivated in England, about three hundred years since.

56. Within the last seven years, the bread-fruit tree has been transplanted from the islands of the South Seas to the West-Indies; and all the rare spices, natives of the East-Indies, are now cultivated in the West-Indies.

57. The Potatoe, so considerable and wholesome a portion of our food, was unknown in Europe, about two centuries ago; but was brought from America by Raleigh. The period is on record (500 years before Christ), when the first wheat was brought into Europe, from Asia Minor. Peas, beans, and all other grain, are exotics in England.

58. Such, also, is the art of man, that he improves whatever he cultivates. By grafting buds of superior fruits on ordinary stocks, he amends, and even alters, the natural produce of the tree; and by managing and selecting his seeds, he improves and enlarges every vegetable production.

59. By the art of Gardening, two, three, or four, persons may derive ample subsistence, from every acre of ground in cultivation; but there is, in no country, without cultivation,

above one human inhabitant to two square miles; and even on that space, subsistence is obtained with difficulty; such are the triumphs of art over nature!

60. In England and Wales there are *ten* millions of inhabitants; and *thirty-seven* millions of acres of ground; of which, nearly *thirty millions* are cultivated, or are employed in grazing cattle; the other *seven* are waste.

There are, consequently, three acres of cultivated ground to every person; and nearly another acre of that which is uncultivated.

Obs.—It having been ascertained, that an acre of land employed as a garden, will produce regular subsistence for four persons; it follows, that if the ground in England was thus cultivated, it would support a population of 120 millions; and, with various allowances, at least 100 millions, or ten times its present number. The ground still uncultivated, might, perhaps, be made to maintain the present number of inhabitants in plenty.

61. Each of the people consumes in every year, one quarter of wheat, being the produce of half an acre; three bushels of barley in *beer*, being the growth of the eighth of an acre; one sheep, one eighth of an ox, one third of a lamb, calf, and pig, being the produce of two acres; and in vegetables and fruits, the produce of the eighth of an acre.

Obs. Hence, every human inhabitant uses the produce of three acres; and the remainder of his share is consumed by horses, or engaged for buildings, roads, hedge-rows and pleasure-grounds, or is devoted to waste.

62. Of the *thirty millions* of acres of land, *nine millions* are employed in arable tillage; *fifteen millions*, in grazing cattle; *one million and a half* in woods and hedge-rows; the

million and a half, in roads, water, and buildings; and *one million*, in hop-enclosures, gardens, and pleasure-grounds; and the remaining *three millions* lie in fallow.

Obs.—The seven millions of waste consist chiefly of commons or heaths; and it is computed, that *four* millions of them are equal to any purpose of cultivation; the other three, are in mountains; or have no depth of vegetable soil.

63. The number of bullocks killed, annually, in England and Wales, is at least a million; of sheep, nine millions; and of lambs, calves, and pigs, nine millions; besides thirty millions of poultry and game; and innumerable small birds and fishes.

The number of horses is nearly two millions; of which a million and a half are employed in agriculture and commerce.

Obs.—It is calculated, that horses consume one-fifth of the entire produce of the land; *i. e.* the produce of four acres per horse on the whole of the land, or two acres each, of that nine millions employed in raising corn.

64. On an average, each man, woman, and child, consumes *ten ounces* per day, of animal food, or 220 lbs. in the year; which, in animal food, is the annual produce of two acres of land.

It is found, however, that the same two acres, cultivated in Potatoes, would yield, on an average, upwards of ten tons per acre, or forty-four thousand pounds weight; and, consequently, afford *one hundred and twenty pounds* of potatoes, per day, the year round!

65. If cultivated in wheat, the produce of the same two acres (which produce but 220 pounds of animal food), would produce 4,000 pounds

weight of grain; or afford ten pounds of wheat per day, leaving sufficient for seed.

Peas and beans yield in the same proportion. Turnips and carrots are as productive as potatoes! but parsnips actually double the weight of potatoes!

Obs.—Mr. Middleton well observes, "that every acre would support its man well, on *vegetable food*; that," says he, "only let him change his diet to one meal per day, of animal food; and he will require the produce of four acres!" The same author observes also, "that the starch, or nourishment of a potatoe, is one-fourth of its entire weight; and that the quantity of starch, or nutriment, on an acre of potatoes, is four times greater than in an acre of wheat!" Those, who seek further information on agricultural subjects, should consult *Young's Farmer's Kalendar*; a work which ought to be found in every farm-house.

IV. *Metallurgy.*

66. Before man could till the ground, dig it, hoe it, or plough it, he required the aid of something harder than the ground itself; that is to say, he wanted iron or metals. Without iron he could have no very useful, sharp instrument—such as the spade, hoe, plough, scythe, or sickle.

67. Hence, till they had discovered the means of obtaining and working iron, men were found to depend for food, on the spontaneous productions of the earth, and on the flesh of animals. Holy writ tells us that Tubal-cain (or Vulcan), was the instructor of all those who, before the flood, worked in brass and iron.

68. Viewing the metals in ordinary use, we consider them common productions; but no art is so curious, as that of extracting metals from the earth, or ore in which they are buried or concealed; and no discovery or invention was ever more wonderful.

69. Metals are very seldom found in a pure state; but perhaps the first discoverer, having found some metal in a detached or pure state, was led to make experiments on those lumps of shapeless and coarse, but heavy earth; which consist of a mixture of earth and metal, and which are called *ores*.

70. Gold-dust is frequently found in the sand of rivers; whither it is washed by the rains from the mountains. This itself might lead to the discovery of metals. Much of the gold used in England, is collected out of the rivers in *Guinea*, on the coast of Africa.

71. Workers of metals imitate nature when they *beat* and *wash* their ores; and, having cleared them, in that way, of much of the earth, they then *burn* them in various ways; and, at length, get the metal by itself in a pure state.

72. No one, on looking at most of the metallic ores, would suspect them to contain metal: they are, apparently, the roughest, coarsest, and least desirable stones, or earths; but, on being broken, repeatedly washed, and burnt, (or, *roasted*, as it is called,) they yield Gold, Silver, Copper, Iron, and other metals.

73. These ores are found in the veins of mountains, or between the strata, or divisions

of rocks; generally beneath the surface of t
ground; and the pits or wells, dug in search
the ore, are called *mines*. The well itself,
called the *shaft* of the mine. Pits, from whi
stone only is extracted, are called *stor
quarries*.

74. The deepest mines are in Hungary; s
are about three-quarters of a mile below t
surface. Many mines are like towns und
ground; and many miners pass their wh
lives in them. The want of fresh air, and t
influx of water, prevent mines from sinki
deeper.

75. All the substances which form the grou
and earth, are called minerals. Clay is a mi
ral; all stones are minerals; coal is a miner
chalk, and, in short, whatever is not animal
vegetable, is called mineral.

76. The study of minerals has been metl
dised, and called the science of mineralog
In this, as in many other branches of scien
little more, however, has been effected, than
attain a systematic classification and nome
clature.

77. All minerals, *i. e.* all earths, soils, ston
and metals, are scientifically divided into fi
classes.

I. *Earthy* Minerals—being all such, as are v
of taste and smell, light and brittle; as m
stone, flint or alles, clay, sand, crystals, sp
gypsum, alabaster, chalk, stones, cornelian
jasper, topazes, sapphires, rubies, emerald
and diamonds.

II. *Saline* Minerals being such, as have

pungent taste, and are heavier, softer, and partly transparent; as common salt, alum, nitre or salt-petre, and borax.

III. *Inflammable* Minerals—being lighter, brittle, opaque, and never feeling cold; as coals, sulphur, black-lead, and amber.

IV. *Metallic* Minerals—being heavier, opaque, cold, *ductile*, capable of being drawn into wire, and *malleable*, capable of being worked into shape. These consist of gold, silver, &c.: see paragraph, 522, for other particulars.

78. Many metals exposed to the air become dusty; that is to say, they imbibe a part of the air called *oxygen*, and the rust is called an *oxide*. If melted and heated on a fire for a considerable time, they also imbibe *oxygen* from the atmosphere; and turn into substances called *oxides*: the process is called *oxidation*.

79. If 10 lbs. of lead be melted and heated in this manner, it will be converted into an *oxide* called red lead; and the red lead so produced, will be found to weigh 11 lbs., the additional pound arising from the imbibed oxygen.

80. *Oxides* may be converted into metals again, by depriving them of their oxygen. In the example of red lead, if it be burnt again with powdered charcoal, the charcoal will detach the oxygen from the oxide, and the lead will be obtained again in its pure state: this process is called *reduction*.

81. Modern chemists consider the whole earth as metallic; and all the different earths to be

nothing more than various oxides, or rust metals, produced by the continued action of air and water on them; and capable, by su ble means, of being reconverted into metals

82. *Platina* is the heaviest of all metals, ing 23 times heavier than water; but it is a dern discovery. The colour is light grey, it cannot be melted in ordinary fires.

83. *Gold* is 19 times heavier than water; the most valuable of all the metals. It is malleable, that an ounce of it will gild a si wire 13,000 miles in length; and it may beaten into leaves; 300,000 of which, are the thickness of an inch.

84. *Silver* is 11 times heavier than wa and next to gold in beauty; such is its ducti that it may be drawn out in wire finer than a

85. *Mercury*, or Quicksilver, is 14 times vier than water; and is remarkable for b liquid like water; and for not becoming s except in cold greater than that which ren water solid.

86. *Copper* is 9 times heavier than water; is found in great abundance in the mine Sweden, and also in the isle of Anglesey. unites well with other metals; and forms a riety of useful compounds.

87. *Iron* is 8 times heavier than water; is the most useful, and, in England, the Abundant of all the metals. It mixes with animal, vegetable, and mineral kingdoms. melted with more difficulty than gold, silve copper; and it usefully strikes fire with fli

Obs.—The loadstone, which possesses the singular and unaccountable property of always pointing to the north, is an ore of iron.

Red and yellow ochres are impure oxides of iron: generally where redness is found in the soil, the presence of iron may be suspected.

88. *Tin* is an English or Cornish metal, 7 times heavier than water. It is very malleable; and is highly useful as a coating to iron and copper; requiring only, to have iron dipt into it, and copper to be rubbed with it, to become perfectly coated.

89. *Lead* is 11 times heavier than water; easily melted, and highly useful for various purposes.

90. *Nickel* is a Chinese metal of a light grey; 9 times heavier than water, and melted with difficulty.

91. *Zinc* is 7 times heavier than water, of a bluish white colour, and used in various compounds.

92. The other metallic substances are Antimony, Bismuth, Cobalt, Arsenic, Manganese, Palladium, Rhodium, Potassium, &c., to the number of thirty; although the ancients knew of only seven metals.

93. Iron is formed into *steel*, by being heated with charcoal. *Brass* is composed of zinc and copper. *Bell-metal* is a mixture of tin and copper. *Pewter* is a mixture of tin and lead. *Bronze* is a mixture of copper and tin.

94. Coals are minerals dug out of the ground in immense mines; particularly at Newcastle, Whitehaven, and Wednesbury; and they are

the best fuel yet discovered by man. The British islands are celebrated for their coal-mines; many countries being obliged to depend on wood; which is often scarce and dear.

Obs.—Coals are, in all probability, the remains of submerged forests, brought to their present state by some unknown process of subterranean chemistry.

95. Half the civilized employments of man, consist in working the metals and minerals. In England, the large towns of Birmingham and Sheffield are wholly engaged in the useful and ornamental manufactures of various metals.

Obs.—All that boys effect with lead and a tobacco-pipe, men effect in regard to all the metals, by similar or slightly-varied means.

96. Civilization depends so much on the discovery of the useful metals, that little progress can be made from a savage state, without the useful trade of a blacksmith.

He makes all the implements of gardening and agriculture; all domestic utensils; knives to cut with; and spears and swords to defend the soil and its produce, against invaders.

97. To avoid the inconvenience of exchanging or bartering, men, in early ages, fixed on metals: as on gold, silver, copper, or iron, for a medium of value: so that, if one man had too much corn and wanted wine, he was not obliged to give corn for the wine, but he might sell his corn for so much metal, and buy the wine with the metal, at his convenience.

Obs.—Hence, the origin of money; and as it was found inconvenient to weigh metal in every transaction, (as Abraham did when he bought the burying-place of Sarah,) ingots were cut on pieces of metal, as bloom-

hands, to indicate that they might be safely received for a settled weight or value. Hence, in England, we have, or had, pieces of stamped gold of known value; as guineas, half guineas, sovereigns, half sovereigns, &c.; pieces of stamped silver, as crowns, shillings, &c.; and pieces of stamped copper; as pennies and half-pennies;—all of universal worth. But of late years, a pernicious attempt has been made, to pass stamped paper for money; originally, mere *promises* to find money, but latterly, as money itself! Gold coin in particular has, consequently, almost disappeared, and become very dear in relation to the paper-money.

N. B. From 76 to 81 was numbered 92 to 97 in the former edition.

V. *Of Building.*

88. Man, like other animals, would seek places in which he might shelter himself from the inclemency of the weather. Beasts of prey retire to thickets and caves; beavers build mud-houses, and rabbits make burrows under ground. Man, in his most savage state, imitates their practices; and then improves on them, by the aid of his reason.

89. Among savage tribes we find, at this day, that the Siberians and Northern Americans reside under ground; having their filthy habitations entirely closed during the winter-months. In warmer regions, the Americans build wigwams of stakes and leaves, and turf, in the shape of a soldier's tent.

In Africa, the materials of the kraals or houses are the same as the wigwams; but the shape is circular, with a hole at the top to let out the smoke; and, in order to keep out beasts of prey,

the entrance is so low, that the inhabitants crawl in and out.

100. A number of these subterranean habitations in one place; or a collection of wigwams or kraals, forms a Siberian, American, or African tribe. In many islands of the South Seas, the natives, when first discovered, had learned to elevate the roofs on poles, and to fill in the sides of their houses with boughs or rushes, mud, &c.

Obs.—The cottages of many of the poor, are still built in this manner in England; and few need travel a mile from their own residence to see the original style of architecture.

101. Those nations which first raised the roofs of their houses on poles, were discoverers in the art. Those which first used stone, however small, and mud or clay to fill up the interstices between the stones, and cement them together, made considerable improvements.

After the discovery of iron and metals, the axe, the hammer, the saw, and the trowel became the tools of builders, it may be supposed that houses would soon be raised to two stories, and increased in size and convenience.

102. To make artificial and equally-durable stones, by burning clay into *bricks*, was another invention of great importance; for it afforded for building an universal material as durable as stone, without the expense of carriage, and often with less labour [illegible] quired to dig and fashion the stone.

The best London bricks are made

ashes; and are nine inches long, four
broad, and two inches and a half

inches, in laying bricks, two in breadth, with
for mortar, are equal to one in length, and
this may
the wall.

The first cement for walls, was either
but, in due time, experience led
preference of a mixture of lime, sand, and
which, for plastering, the hair of oxen
ded. Trees presented the next build-
rial, for beams, and boards in floors.

lime is a stone deprived of its carbonic acid
fire; by mixing it with sand and
ed air, you restore the lime to stone again in a
Hence the composition of mortar.

bricks and mortar, therefore, well laid
bricklayer; with wood well put together
s, by a *carpenter*; the dwellings of the
civilized world are now made.

Cast-iron for many purposes, to which timber
applied, has lately been used to great ad-

Simple as is the contrivance of chimnies
off smoke, they are yet a recent inven-
d, in building, were unknown till within
five hundred years; down to that period,
ke escaped through a hole in the roof of
e.

dle contrivance, between a hole in the
a close fire-place, was the open chim-
nst the wall; which we yet see in many
-houses; and the family sit under the
t carries off the smoke.

C

105. The means of letting in the light, and keeping out the cold, is also a recent invention. Anciently, holes for light were made with wooden shutters, to open by day, and to close at night.

Various were the contrivances to let in light; and, at the same time, to keep out cold. Bladders, horn, and membraneous substances of animals and fish, were used for this purpose, in the houses of the great: but all these gave way to the fine invention of glass.

106. That useful material was discovered by accident: some Phœnician carriers of soda, a few years before Christ, happening to light their fire between some of their lumps of this mineral, it melted, and mixing with the sand, produced glass. Soda and sand, or flints, melted together, continue to be the materials of which glass is made to this day.

Obs. 1.—The manufactory of glass was long confined to Phœnicia; but so little improvement was made in it, that Nero gave 60,000*l.* for two glass cups that had handles. It was first applied to windows about the year 300; but did not get into general use till about 1000.

2.—A glass-manufactory is a proper object to gratify the curiosity of young persons. Flint, or purified stony sand, called *silex*, is mixed with pure soda, and exposed to a moderate heat, producing what is called the *frit*; this is then put into moderate-sized vessels, and exposed to a violent heat, till melted; and, on cooling a little, it becomes a kind of hot paste, which may be worked and moulded to any shape:—the ingenuity and expertness of the workmen, in so moulding and shaping it into various vessels, is highly amusing.

107. Tiles for the roofs of houses are made of clay, in the manner of bricks. Slates, [illegible] from quarries, are also used for the same purpose.

In country-places, where the earliest practices are still continued, roofs are thatched with straw: these will keep out the wet and cold, but generate a musty smell.

Paints, consisting of the oxides of metals, and of certain coloured earths, or natural oxides, mixed with oil, at once serve to preserve wood, and to purify and beautify the inside of houses.

VI. *Of Architecture.*

108. After the art of building had attained what was useful and necessary; Luxury would aim at ornament:—an ingenious carpenter would become a carver; and an ingenious stone-mason, a sculptor.

The pillars which supported the work, would not be allowed to be quite plain; but would be cut or carved in ornaments, at the head and base; and other parts of the room, or structure, would be made to correspond. Hence, arose what are called, the five orders of Architecture.

109. The five orders of architecture were successively invented in ancient Greece and Italy; and are called the TUSCAN, the DORIC, the IONIC, the CORINTHIAN, and the COMPOSITE. they are to be found in all the principal buildings of the Christian world.

110. The Saxons, also, had a simple style of architecture; distinguished by semicircular arches and massive plain columns; these are still found in many of our oldest buildings.

The Normans, too, invented a beautiful style

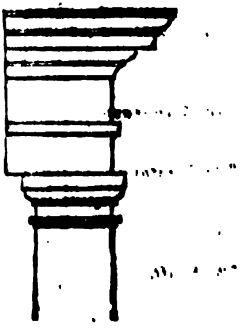
of architecture, called the Gothic; distinguished by its lightness and profuse ornaments; by its pointed arches; and by its pillars, carved to imitate several conjoined.

The Gothic architecture is found in all our old cathedrals; and is often elegantly adopted in private dwellings.

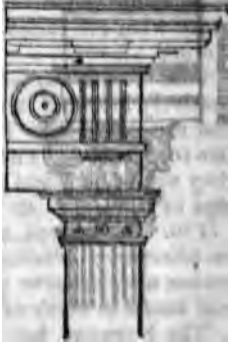
Obs. 1.—As a more effectual means, than any verbal description, of conveying a knowledge of the several species of architecture, diagrams of the characters of each are given below; and to fix them in his recollection, the pupil should trace or copy them.

2.—The Hindoos, Egyptians, Chinese, and Moors have likewise their own separate styles of ornamental building: nothing can be more grand, harmonious, and picturesque, than each of these, in the splendid specimens which are to be seen in their several countries. In England, the Pagoda in Kew Gardens is a pleasing specimen of Chinese architecture; but we seem, in general, to prefer the five orders; to the Gothic.

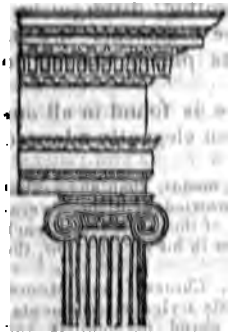
1. THE TUSCAN ORDER.



2. THE DORIC ORDER.



3. The IONIC order. 4. The CORINTHIAN order.



5. The COMPOSITE order.

The Cornice.

The Frieze.

The Architrave

The Capital.

The Shaft.

VII. *The Art of Clothing.*

111. Most animals are provided with a
of hair or wool for covering; but man seem
have been left naked, and, in many respects,
titute; apparently, to serve as a stimulus t
industry and invention.

Man seems, as to his own wants and pow
to have been formed to equalize climates
conquer the elements. His superb edifices,
control of fire and water, his applicatio
light in the night, and his various clothing,
tinguish his superior intellect.

112. In all climates, clothing is not alike
cessary; between the tropics it is little requi
except for ornament; but, in the temperate
frigid zones, man could scarcely subsist wit
some covering.

Holy Writ tells us, that the first clothin
Adam and Eve was the leaves of fig-trees, s
perhaps, together; and, even at this day,
manufactures of clothing are derived, chi
from the fibres of the vegetable kingdom.

113. The skins of animals were doubtless
first substantial clothing. The shepherd w
dress himself in his sheep or goat's skin;
the hunter, as a trophy, in the skin of
beast.

The Tartars clothe themselves in horse-h
to this day; the Americans, in the skins of
fulces; and, even in some parts of Europ
sheep's skin, with the woolly side inward or
ward, makes a winter or a summer-garment

114. Some natives of the South-Sea isl

clothe themselves in mats made of reeds or vegetable fibres; others render pliable the common bark of trees; but none of these will wash, and they are not durable.

Civilized man, however, adapts the means of nature to his purposes, by a process of his own; he separates the fibres themselves, then twists them into thread, and by interweaving this thread, he obtains a pliable and durable material.

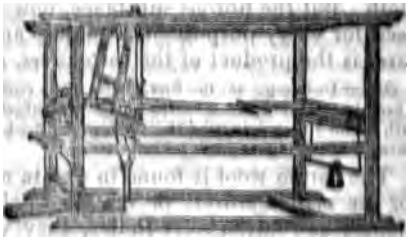
115. The most useful plant for this purpose, is *flax*. It is cultivated like wheat; and, as soon as its seeds are ripe, it is pulled up by the hand: the seed-vessels are taken off, and the stems are put into pits of water, till the mucilaginous or other matter, which holds the fibres of the stalk together, is decayed.

116. After the stalks have been taken out of the pits, they are dried, beaten, and combed, till what remains is fine, loose, and shining: the flax is then spun, or twisted by a distaff, and wound on a reel or spindle. This thread is either adapted for needle-work, or is given to the weaver to be woven into linen cloth by his loom.

117. The process of weaving is simple:—the threads in their length are called the *warp*; and are drawn tight by weights at one end; at the other, they are divided into two sets, each set composed of alternate threads;—on moving a treadle, one set, or every other thread, is thrown up, and the other set is brought down; and, at this instant, a cross thread or woof is thrown between them by means of a shuttle.

The lower set of ends are then raised; and the other brought down, and the woof is again thrown between. The operation is thus continued, till the whole length of the warp has been interwoven with cross threads.

Obs. 1.—A figure of a simple loom is here given; in which, the parts referred to above may easily be traced. The forms of looms are, however, various, and often very intricate. There are stocking-looms, or frames, silk looms, cloth-looms, cotton-looms, linen-looms, cambric looms, carpet-looms, lace-looms, &c.



Obs. 2.—As the loom is one of the most important of useful machines, its principle of action ought to be well understood. Look at a piece of linen with the eye, or with your simple magnifier, and it will be seen, that the loom has simply crossed the threads, and thereby matted the whole together. The four fingers present themselves, as the most simple illustration of its action; but the student may fasten six or eight pieces of string to a wall, to represent the warp; and then by raising every other one, and depressing the others, he will be able to pass the woof by any contrivance, which will represent the shuttle. He may thus make a piece of packthread-cloth; and so, completely illustrate the principle of weaving.

118. After the piece has been woven, it requires to be bleached by the air and sun, or by exposure to some acid. It is afterwards, if de-

sired, printed to any pattern, by means of blocks of wood, cut out to the pattern, and is then pressed and glazed before it is used.

Much skill and experience are required in fixing colours, so that they will not wash out, but in printing, dying, and similar arts, the Hindoos and Chinese excel all nations.

119. *Hemp* is another fibrous stalk, much cultivated for the manufacture of ropes and sail-cloth. But the fibrous substance, now the most used for every purpose of clothing and furniture, is the product of the *cotton-tree*, or plant.

Obs.—In hemp, as in flax, it is the cortical part which is required for the use of the manufacturer; the pith or medullary part of the stalk being broken and separated from it.

The cotton wool is found in a state nearly fit for the manufacturer, in the seed-pod of the plants; and in the West Indies, they yield two crops in the year.

120. Hundreds of ships arrive every year from the West Indies, laden with this material. The chief manufactories of cotton are in Lancashire and Lanark-shire; and they are wonders of human invention.

The articles used in clothing, produced from this substance, are muslins of every degree of fineness, corduroys, sheeting, calicoes, quilting, bed-furniture, hangings, &c.; all of which have been the means of extending the commerce of Britain to every part of the world.

Obs.—Manufactories of cotton are now scattered all over the United Kingdom; and employ a million of men, woman and children.

121. The wonderful operations of a COTTO MILL, have been so correctly described by D win's that they will be much better remembe in that form, than in prose:

First, with nice eye, emerging maidens cull
From leathery pods, the vegetable wool;
With wiry teeth *revolving cards* release
The tangled knots, and smooth the ravel'd fleece
Next, moves the *iron hand* with fingers fine,
Combs the *wide card*, and forms the eternal line;
Slow, with soft lips, the *whirling can* acquires
The tender *shoins*, and wraps in rising spires;
With quicken'd pace *successive rollers* move,
And these retain, and those extend, the *rove*;
Then fly the *spoles*; the rapid *axles* glow;
While slowly circumvolves the lab'ring *wheel* bel

122. Civilized man does not disdain to c vert the covering of animals to his purpo but he changes their appearance, and prepa them, so as at once to preserve and clear th from offensive odours.

One of the most common articles of exter clothing is derived from the wool of the she and this forms the most admired and useful, the native manufactures of Great Britain.

123. The *fleece*, as it comes from the anim is first picked and sorted; and then clean from stains, dirt, and grease. The wool com afterwards prepares it for the spinner; t twists it into woollen-thread called *worsted*, *yarn*. Of late years, the twisting has been p formed by worsted mills, on the plan of cott mills.

124. This yarn, or worsted, is then wove loom into cloths, flannels, or stockings, of

rious degrees of fineness, according to the
ture of the fleece: the weaver delivers the clo
to the fuller; who, by means of *fuller's* ear
deprives it of all remaining grease.

It is, afterwards, dyed of any required colou
then it is pressed, and, finally, sold under
name of broad and narrow cloth, to the drap
tailor, or merchant.

Obs.—England and Wales feed 36 millions of shee
each of which, yields a fleece of four pounds weight;
144 millions of pounds at 1s. per pound, value 7,400,0
These manufactured, produce 20 millions of pounds st
ling; leaving a profit of upwards of 12 millions per
num, to the manufacturers.

125. Carpets are another production of wo
and in making them, the warp is worked p
pendicularly instead of horizontally. The f
shawls of the East, (lately so well imitated
this country,) are made from the fine wool of
sheep, which range the mountains of Thibet.

Obs.—Cable-ropes, of superior strength and durabil
have lately been made from the long wool, which is
less for cloths.

126. Man's finest clothing, however, is
rived from the web of a crawling insect, or
terpillar, called the silk-worm. All the co
ries of the south and the east preserve
propagate this insect; and the produce of
labours, forms a considerable article of co
merce with China, India, Persia, Turkey, Ita
and the South of France.

127. The worm is hatched by the heat of
sun, from eggs laid by a lively moth in
preceding year. Its food is the leaves of
mulberry; in which tree it lives in warm

mates. After it attains its full growth, it
itself in its silky web, attached to one
leaves; and in this cone of silk, it is co
into a chrysalis!

128. In a few days, the chrysalis pre
lively and delicate moth, which eats its
of the cone of silk; flutters its wings
days, lays eggs for future supplies of sil
—and then dies! Such is the curious
derful economy of this insect, which
man with the material of silk. See t
ter paragraph 505.

129. The cones of raw silk are
size of a pigeon's egg! and each of t
wound off, contains, in length, a q
mile! These webs, after slight pr
are spun into thread, by machinery i
and then called *organzied* or *throw*
weaver converts the thread into the
gant fabrics made of silk, and th
presser finish them for consumptio

Ob.—Attempts have been made to re
the spider useful; and stockings have actu
of this material! In short, whatever ma
thread, he contrives to weave into garme
respect there is no bound to his material

130. Hats are made of the fin
mals, felted, or beat; and then
ther, till they are tenacious and
and gloves are made of the hid
first prepared by the tanner and
pelling the fatty and unctuous
animal, and infusing into its
ment, made of oak-bark.

Skins are steeped many weeks in the tan-pits or bark infusions, undergoing this conversion; and they are then shaved and coloured by the currier, for their various uses.

VIII. *Of Government and Laws.*

131. The heads and fathers of Families were anciently their governors; and this kind of government, was called Patriarchal. The histories of Abraham, Isaac, and Jacob, are beautiful illustrations of this state of human society.

132. When the family grew too large, the branches sometimes separated, as we observe in the instance of Abraham and Lot, and of Jacob and Esau; but when they resided together, some one would be regarded as the head: in due time, a title would be given to this ruler; and he would be called a chief, captain, judge, dictator, king, sultan, or emperor.

133. Such was the origin of governments; and they would prove of various tendencies, according to the character of the first rulers. Any quarrel between two tribes, would give to both of them a military character.

He who got the better, would be in danger of being inspired with a love of conquest; hence, much misery would arise. In time, many tribes or families would unite into one; as well for offence as defence; such, doubtless, was the origin of nations.

34. The land of Canaan, when invaded by the Israelites, was sub-divided in this way, into

petty tribes; so was Britain, when it was invaded by Cæsar; Italy, also, was divided in the same way, before the ambition and military character of certain Romans led them to make war with their neighbours.

Such, too, is the state of five thousand nameless tribes in North and South America; in Africa, Tartary, and Siberia, at this day.

135. Every man in a society, or nation, is bound to respect its welfare; to do nothing injurious to its members; and to conform himself to the rules or laws by which it is held together, maintained, and protected. By obeying the laws himself, he sets an example to others and he also partakes of the common benefit and protection afforded by them.

What constitutes a state?
Not high-rais'd battlement or labour'd mound,
Thick wall or moated gate;
Not cities proud, with spires and turrets crown'd,
Not bays, and broad-arm'd ports,
Where, laughing at the storm, rich navies ride;
Not starr'd and spangled courts,
Where low-bred baseness waft perfume to pride,
No—Men, high-minded men,
Men who their duties know,
But know their rights, and knowing dare maintain,
Prevent the long aim'd blow,
And crush the tyrant while they rend the chain.
These constitute a state. SIR. W. JONES.

136. A Constitution is that plan of government and system of laws, under which a people live together in the same society. In Britain, for example, we have a chief magistrate, a King, to execute the laws and conduct the bu

ness of the government; and we have two houses of parliament, to concur with the king in making laws, and levying money: this arrangement is called the Constitution of Great Britain.

137. The two houses of parliament consist of about 400 peers, or nobles, in the House of Lords; and of 658 members, elected by and representing the people, in the House of Commons.

No law can be enacted without the joint consent of the king, lords, and commons; and nothing can be done contrary to the laws so made; or to the established and known customs, or Common Law, of the country.

138. No tax can be levied on the people, unless it originates in the House of Commons; and is first approved of by that assembly. The creation of peers and transactions with foreign nations, belong to the office of King; as do the direction and appointment of the Army and Navy, and the management of Wars.

139. The laws of England consist of the *Common* Law, the *Statute* Law, and the *Civil* Law.

The *Common Law* is the ancient Law of England, supposed to be derived from the Saxon laws, and founded on principles of reason and justice, on the revealed laws of God, and on the immemorial customs and rights of the people.

The *Statute Laws* are particular laws to declare, enforce, and modify, the common law; and are made by the two Houses of Parliament, and assented to by the King.

The *Civil Law* is the law of our spiritual courts and universities; and is derived from the ancient laws of the Romans, as condensed into a code by the emperor Justinian.

140. The laws are administered in the king's name, in the courts of King's Bench, Exchequer, and Common Pleas, and also at assizes in county towns, by two judges; of whom, there are twelve in England.

There is also a court of Equity, called the Court of Chancery; in which, in particular cases, the letter of the law is moderated.

OBS.—There is danger in every country, that those who use and practise the law may abuse it; and such now is unhappily the case in Britain;—the people being ground to powder, and vilely abused by the chicanery and villany of low attornies. A code, such as that made by Justinian, is now called for in England;—the people may be relieved from the vexation of law-suits by arbitrations; but *they should never refer to a barrister or lawyer.*

141. There are also courts of quarter-sessions held by justices of the peace, for trying petty offenders; and by corporate bodies, who act under the king's charter.

Courts of request, or of conscience, are instituted for the recovery of debts under five pounds.

142. In Britain no man can be put on trial, for any offence, unless twelve of a GRAND JURY have declared, in a bill of indictment, that there is cause for trying him; and he can not be convicted or punished, except a verdict has been given against him by another Ju-

composed of twelve honest and unexceptionable men.

143. By our laws, wilful murder, forgery, house-breaking, house-burning, horse and sheep-stealing, rape, highway-robbery, cutting and maiming, piracy, coining, and treason against the king, are punishable with death.

144. Numerous other offences are also punishable with death; but the sentence is generally commuted into transportation for life: smaller offences involve transportation for fourteen or seven years; and petty ones are punished by imprisonment, whipping, pillory, burning in the hand, or by fines.

145. A man who has committed a crime, is charged with it before a *justice of the peace*; who issues his *warrant* to the *constable* for his apprehension.

The justice commits him to the custody of the sheriff in the *county gaol*, on the *oath* of the accuser; who, at the *assizes*, must repeat his charge before *the grand jury*.

If they find *a true bill*, he is then tried before the *petty jury*: and, on being found *guilty*, receives from the *judge*, the *sentence* of the *law*.

146. Death is inflicted by hanging: transportation is made to Botany Bay, in New Holland; but many such culprits are employed in England on board of hulks, or old ships: small offenders are sent to houses of correction, and kept to hard labour.

As the king is the executor of the la
as all prosecutions are carried on in hi
he has the power of pardoning criminal

147. The constitution of Great Bri
cures the liberty, as well as the good
ment, of the people;—

Because no law can be made, with
consent of their representatives in the H
Commons.

Because no tax can be imposed, unle
ginates, and first passes, in that house.

Because no man can be punished, in
without the consent of twenty-four of h
or equals; i.e. by twelve of a grand, an
of a petit jury.

148. The public rights of Britons are
cured by Magna Charta, by the Habeas
Act, by the Bill of Rights, and by innu
acts or statutes of parliament passed o
the reign of Edward the First, and Wil
Third.

Obs.—The two most enlightened countries in
having published the general principles of go
the one in a document, called the BILL OF RIGHT
and the other in a DECLARATION OF RIGHTS,
both are subjoined as the most complete, and
objectionable summaries that were ever con
these subjects.

*The Lords spiritual and temporal, and Commo
land*, being assembled in a full and free repres
the nation, did, (as their ancestors in like case h
done) for vindicating and asserting their ancie
and liberties, declare,

1. That the *pretended* power of suspending
or for the execution of laws, by regal authority
consent of parliament, is illegal;

2. That the pretended power of dispensing with laws, or the execution of laws, by regal authority, as it hath been assumed and exercised of late, is illegal:

3. That the commission for erecting the late court of commissioners for ecclesiastical causes, and all other commissions and courts of like nature, are illegal and pernicious:

4. That levying money for, or to the use of the crown, by pretence of prerogative, without grant of parliament, for longer time, or in all other manner than the same is or shall be granted, is illegal:

5. That it is the right of the subjects to petition the king; and all commitments and prosecutions for such petitioning are illegal:

6. That the raising or keeping a standing army within the kingdom in time of peace, unless it be with consent of parliament, is against law:

7. That the subjects which are protestants may have arms for their defence, suitable to their conditions, and as allowed by law:

8. That election of members of parliament ought to be free:

9. That the freedom of speech, and debates or proceedings in parliament, ought not to be impeached or questioned in any court or place out of parliament:

10. That excessive bail ought not to be required, nor excessive fines imposed, nor cruel and unusual punishments inflicted:

11. That jurors ought to be duly impannelled and returned; and jurors which pass judgment upon men in trials for high-treason ought to be freeholders:

12. That all grants and promises of fines and forfeitures of particular persons before conviction, are illegal and void:

13. And that for redress of all grievances, and for the amending, strengthening, and preserving of the laws, parliaments ought to be held frequently.

And they do claim, demand, and insist upon all and singular the premises, as their undoubted rights and liberties; and that no declarations, judgments, doings, or proceedings, to the prejudice of the people in any of the

said premises, ought in any wise to be drawn
to consequence or example.

Again, in 1789, the National Assembly of F
organized and declared, in the presence of the
Being, and in the hope of his blessing and fa
following sacred rights of men and citizens.

1. Men are born, and always continue, free
in respect of their rights. Civil distinctions,
can be founded only on public utility.

2. The end of all political associations, is, t
vation of the natural and imprescriptible right
and these rights are liberty, property, securit
distance of oppression.

3. The Nation is essentially the source of
reignty, nor can any individual, or any body
entitled to any authority which is not expres
from it.

4. Political liberty consisting in the power
whatever does not injure another; the exerc
natural rights of every man, has no other li
those which are necessary to secure to every
the free exercise of the same rights; and these
determinable only by the laws.

5. The law ought to prohibit only actions
society. What is not prohibited by the law, s
be hindered; nor should any one be compelled
which the law does not require.

6. The law is an expression of the will of th
nity; all the people have a right to concur, ei
sonally, or by their representatives, in its forma
should be the same to all, whether it protects or
and all being equal in its sight, are equally e
all honours, places, and employments, according
different abilities; without any other distinc
that created by their virtues and talents.

7. No man should be accused, arrested, or he
finement, except in cases determined by the l
according to the forms which it has prescrib
who promote, solicit, execute, or cause to be

arbitrary orders, ought to be punished: and every person called upon or apprehended by virtue of the law, ought immediately to obey; and he renders himself culpable by resistance.

8. The law ought to impose no other penalties than such as are absolutely and evidently necessary; and no one ought to be punished, but in virtue of a law promulgated before the offence, and legally applied.

9. Every man being presumed innocent, till he has been convicted, whenever his detention becomes indispensable, all rigour to him more than is necessary to secure his person, ought to be provided against by the law.

10. No man ought to be molested on account of his opinions, not even on account of his religious opinions; provided his avowal of them does not disturb the public order established by the law.

11. The unrestrained communication of thoughts and opinions, being one of the most precious rights of man, every person may speak, write, and publish freely, provided he is responsible for any abuse of this liberty, in cases determined by the law.

12. A public force being necessary to give security to the rights of all the people, that force is instituted for the benefit of the community, and not for the particular profit of persons with whom it is entrusted.

13. A common contribution being necessary for the support of the public force, and for defraying the other expenses of government, it ought to be divided equally among the members of the community, according to their ability to pay.

14. Every person has a right, either by himself, or his representative, to a free voice in determining the necessity of public contributions; the appropriation of them to their amount; their mode of assessment, and their duration.

15. Every community has a right to demand of all its agents an account of their conduct.

16. Every community in which a security of rights is not provided for, by a separation of powers, [illegible] constitution.

17. The right of property being inviolable and sacred, no one ought to be deprived of it, except in case of

evident public necessity, legally ascertained, a dition of a previous just indemnity.

*** *Students who desire to become more intimately acquainted with these subjects, should consult Blackstone's Commentaries on the Laws of England; Dela Constitution; Miller on the Constitution; or, C British Geography. On other public subjects, Sm Wealth of Nations, and Gianthi on Political Eco valuable works.*

140. The enjoyment of private p which is the stimulus of industry, and t dation of social order, is secured by the law of the land, and by the intervent jury; who decide in cases of private as well as in cases of public injury, or cr

150. Property is divided into real a sonal: real property consists of lands a appendages, and of houses and other bu personal property signifies moveables cattle, and every thing, in which the ho but a temporary interest.

151. Real property is held *in fee-sim* by the party and his heirs for ever; or *by entail*, i. e. by him, and his own chil by him, and afterwards to go to some pa person. Estates may also be occupied, or by *lease* on certain conditions, for a years; or *at will*, for an annual rent.

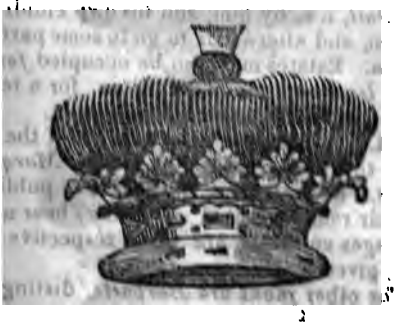
152. The house of peers consists of th ces of the blood royal; of *Dukes*, *Mar Earls*, *Viscounts*, and *Barons*. The pu of their rank, and that which they bear carriages and seals, are their respectiv nets, given below.

The other ranks are *Baronets*, distin

bloody ..... d the arms; and ...ghts, distinguishe by the helmet; Es... are so by ... on office; and ...tlemen, having 30 ... annum in rea... perty.

THE KING, OR REGAL CORONET.

THE DUKE.



THE MARQUIS.

THE EARL.

THE VISCOUNT.

THE BARON.

). The heads of the Church represent that lishment in the House of Peers; and con- the *Archbishops* of Canterbury and York, of *twenty-four* English, and *four* Irish ps.

ıer dignitaries of the church are *Deans*, or ants to the bishops.

ch-Deacons, or subordinate bishops.

ral Deans, who preside over part of the se.

ctors or *Vicars* of parishes, according as receive the great, or small tythes.

d Curates, who receive a salary for doing leric[illegible] duty.

l The twelve Judges sit occasionaly in louse of L[illegible], but they do not vote. In

the Law, there are also *Recorders*, or Ju
corporations; *Serjeants at law*; *Barri
Counsel*; *Solicitors* and *Attornies*.

The *Attorney* and *Solicitor-general* a
risters, who plead in all the legal busines
Crown.

155. *Sheriffs* are officers, who are the
tive deputies of the King in their count
serve all writs and process; keep the p
name and summon juries; execute sente
the law.

Coroners are officers appointed to
into the causes of sudden deaths.

Justices of the Peace hear complaints
mit offenders for trial, to the sheriff's
prison; and redress many grievances.

Headboroughs are constables of Hun
and petty *Constables* execute the warr
justices.

IX. *Of the Art of War.*

156. When a people have acquired
of cultivating the soil, of mining, of
houses and edifices, of manufacturing
of clothing and furniture, and have esta
a government which adds to their ha
and prosperity, they become objects of
their less provident neighbours; and w
invaded, plundered, and despoiled, if th
looked to cultivate the art of war.

156.—War is, however, only justifiable when *defensive*; and is the most enormous of crimes when offensive and unnecessary. No glory attends victory in an unjust war; and, without justice and necessity on their side, the greatest generals are but leaders of banditti, committing murders and robbery.

They seek diversion in the tented field,
And make the sorrows of mankind their sport;
But war's a game which, were their subjects wise,
Kings would not play at. Nations would do well
T' extort their truncheons from the puny grasp
Of heroes, whose inform and baby minds
Are gratified with mischief, and who spoil
Because men suffer it, their toy, the world

COWPER.

157. For securing its independence, the whole male population of a nation ought to be trained to the use of arms; magazines of provisions should be secured; and such dispositions made, as should prevent the country from being conquered by the loss of a single battle.

158. It is usual, however, in modern states, to hire and pay for this service, a certain portion of the male population, called Soldiers. In England and its colonies we have, in time of war, about 300,000 fighting men; whose time and lives are devoted to their country, and they are called *the Standing Army*.

159. We had in the late wars 30,000 *cavalry*, or horse-soldiers; 150,000 *infantry*, or foot-soldiers; and 5,000 *engineers* and *artillery-men*, whose duty was to direct fortifications, and to manage cannon in the field.

We had, besides, 80,000 *militia* and *fencibles*,

who served for a limited period, and
go abroad; 20,000 *marines*, soldiers wh
on board of ship; and 10,000 local vo
horse and foot.

100. Such was our army; yet France a
nations have even larger armies. The
Britain lies chiefly in its Navy; whic
bulwark of the country against invad
has long been the triumphant and un
master of every sea on the globe.

Obs.— As Britain can never be invaded whi
is triumphant, defensive or just wars are odi
ous to the British people.

101. An army is divided into *lie*
consisting of 700 cavalry, or 1,000 i
and each regiment is again subdivided
companies. Some regiments consist o
three battalions; but each battalion
consists of as many men as whole regi
one battalion.

Three regiments form a *brigade*; sev
guides, according to the size of the arr
a division; and three divisions, the cen
sion, and the right and left wings, unit
an army in actual service.

102. An army is commonly commun
a *general*, called the Commander-in-C'h
divisions or wings, by *lieutenants-ge*
majors-general; the brigades, by *br*
generals, and so far they are *staff-officer*

Regiments are commanded by *col*
lieutenants-colonel, who, with *majors*, a
officers.

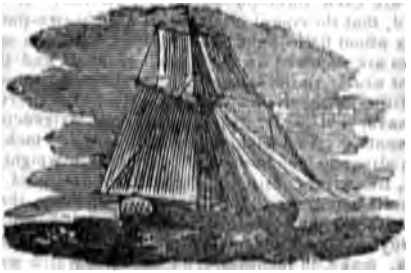
e companies of a regiment are commanded *captains* and *lieutenants*; each company ovided with an *ensign*, to carry its distin- ishing colours; and also with four serjeants, four corporals.

3. The British navy consists of 700 or 800 ips; of which, 200 carry from 64 to 120 , and from 500 to 900 men, and are called s of the Line; 200 more carry from 28 to uns, called Frigates; and 350 carrying less 28 guns, are called Sloops, Brigs, Cutters, ships, Bomb-vessels, &c.

A SHIP.

A BRIG.

A SLOOP.



Obs.—Of all the arts and professions which, at
time, attract notice, none appear more astonishing
marvellous than that of navigation, in the state in wh
it exists at present. This cannot be made more evid
than by taking a retrospective view of the small craft
which navigation owes its origin; and comparing th
to a majestic first-rate, containing 1,000 men, with t
provisions, drink, furniture, apparel, and other ne
saries for many months, besides 100 pieces of heavy c

and bearing all this vast apparatus safely to the tant shores. A man in health consumes, in the twenty-four hours, about eight pounds of vic- l drink; consequently, 8,000lb. of provisions are l, daily, in such a ship. Let us then suppose her ited out for three months, and we shall find, that be laden with 720,000lb. of provisions. A large o pounder weighs about 6,100lb., if made of id about 5,800lb., of iron; and, generally, there nty-eight or thirty of these, on board a ship of ; the weight of which, exclusive of that of their s, amounts to 183,000lb. On the second deck, wenty-four pounders; each of which weighs 100lb., and therefore altogether, 183,000lb.; and ght of the twenty-six or twenty-eight twelve- s on the lower deck, amounts to about 75,400lb.; he fourteen six-pounders on the upper deck, to 6,000lb.; and beside that, on the round-tops, e even three-pounders and swivels. If to this that the complete charge of a forty-two-pounder about 64lbs., and that at least upwards of 160 are required for each gun, we shall find this to nearly to the same weight as the guns themselves. ion, also, to this, we must reflect, that every ship ve, by way of providing against exigencies, at other set of sails, cables, cordage, and tacklings, ltogether amount to a considerable weight; the likewise, consisting of planks, pitch, and tow; ts belonging to the officers and sailors; the sur- tores, and various other articles requisite on a yage; with the small-arms, bayonets, swords, and make no inconsiderable load; to which we must add, the weight of the crew; so that one of these ips carries, at least, 2,162 tons burden, or 10lb.; and, at the same time, is steered and go- with as much ease as the smallest boat.

A fleet of ships of war is generally divided ree divisions; and commanded by Admi- Vice-admirals, or Rear-admirals, of the blue, and red Flags. A ship is com-

manded by a Captain, assisted by two
some instances, six Lieutenants; under
ers, from four to twelve Midshipmen.

There are also a master and his
boatswain and his mate, a purser, a surg
a school-master, with a captain of every

105. There does not exist a more pr
and wonderful combination of human i
than is visible on board a first rate ship
it appears incredible that a vessel, as
the largest parish church, should be ma
directed in the water with nearly the s
pidity and precision as a small boat; a
wonderful that human hands could ha
cated and put together such gigantic mas

106. The immense ropes and cables
of hemp spun together; the aggregation
here lately grew separately in the fore
iron-work was melted and prepared
ore; the cannon were cast in the foun
short, the whole fabric has been drawn
gether by man from the raw productio
earth!

107. Forts and castles are constr
thick walls of brick, stone, or earth; s
in straight lines, but projecting and i
so that one part may protect and cover
and so that the walls may stand obliqu
fire of an assailant. Forts are also provi
wet or dry ditches; and with mines u
adjacent ground, to blow up an appr
enemy.

The projecting angle, or work of a for-
ı, is called a *bastion*.
ıtraight wall that joins bastions, and
ese are to defend, is called the *curtain*.
projecting angles are called *salient an-*
ıd the angles which point inwards are
ıe *re-entering* angles.
ı beyond the ditch are called *out-works*
sloping bank of earth all round is calle
is.
ıpper part of the wall is the *parapet*;
walk within the wall is called the *ram-*

In the cut, N L A P is a bastion.
ıe face of the bastion.
flank.
gorge.
ı counterscarp.
flanked angles.
ı the salient angles
re-entering angles.
rampart.
line of defence.

169. No fortress can be prudently by besiegers within the range of its cept by digging an approach in a s slant direction, something like the c having approached in this way, a raised in the night, and the attack be

Afterwards other zig-zag approa made, called *parallels*; and other bat constructed nearer and nearer, till a made, and the place taken by assault lation.

170. The composition of gunpowde noticed by Roger Bacon, an English 1280; but Swartz, a German monk, in projecting heavy bodies, about 132

The first cannon were used by our K in 1346, at the battle of Cressy, and a of Calais in 1347.

Portable cannon, called muskets, used by the Spaniards about 1500; were very clumsy, being supported from the ground, and fired by a matc

Locks of flint and steel, called were not introduced till the wars of W and Queen Anne.

171. A ball, at its discharge fro moves in a velocity of twenty miles in or one mile in three seconds.

The distance depends on the weig ball, and the quantity and quality o der; but a ball goes the furthest piece is elevated to an angle of 45 deg

there are tables constructed for every degree of elevation.

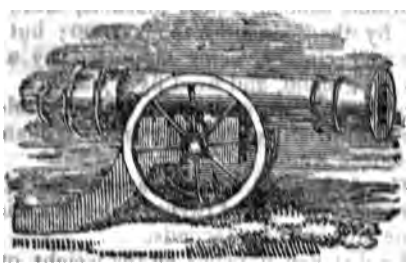
In battle, it is found that not more than one ball in 60 does execution, owing to their rising, when they first leave the gun.

172. Formerly cannon were made so large, as to discharge stones of 100lbs. weight, to a distance of five or six miles, but it is now found that the largest convenient size is a 48-pounder; those carrying 24lb. shot are preferred.

Ship-guns are from 48 to 3 pounders; guns in forts and castles are from 18 to 42-pounders; field-pieces, or flying-artillery, are 6, 9, or 12-pounders.

The best gunpowder is made of 25 parts of nitre, five of charcoal, and three of sulphur.

A CANNON.



Obs. 1.—Before the invention of gunpowder, large stones, equal to mill-stones, were thrown by machines called *ballista; and battering-rams* were used to make *breaches in the walls of cities.*

8.—The modern art of war, aiming at des- means of destruction existing in fire-arms and attains its objects chiefly by rapid movements, b- ing the line of battle, and by passing into the re- enemy, seizing his magazines, and destroying h- munications. The great victories of Bonapa- the generals and potentates in Europe, were ga- these means.

9. On the dreadful subject of war, which ou- not to be undertaken, except when unavoidabl- self defence, Porteus, Bishop of London, write- lowing impressive lines:

'Twas Man himself
Brought Death into the world; and Man himse-
Gave keenness to his darts, quicken'd his pace,
And multiply'd destruction on mankind.
With joy Ambition saw, and soon improv'd
The execrable deed. 'Twas not enough
By subtle fraud to snatch a single life,—
Puny impiety! whole kingdoms fell
To sate the lust of power: more horrid still,
The foulest stain and scandal of our nature
Became its boast. One murder made a villai-
Millions a hero. Princes were privileg'd
To kill, and numbers sanctified the crime.
Ah! why will kings forget that they are men!
And men that they are brethren? Why delig-
In human sacrifice? Why burst the ties
Of nature, that should knit their souls togethe-
In one soft bond of amity and love?
Yet still they breathe destruction, still go on
Inhumanly ingenious to find out
New pains for life, new terrors for the grave,
Artificers of Death! Still monarchs dream
Of universal empire growing up
From universal ruin. Blast the design,
Great God of Hosts, nor let thy creatures fall
Unpitied victims at Ambition's shrine.

X. *Of the Mechanical Powers.*

173. Without the aid of art, man could not raise massy stones to the tops of churches and palaces; he could not apply immense beams of timber to his purposes; in short, he would still have been a builder of huts and cottages. He would, however, soon discover the use of a *lever*; and the principle of that power would soon be applied, in various shapes.

Obs.—A lever is the foundation of all the mechanical powers. It is nothing more than a straight stick or bar of wood or iron; and any common lever may be applied in an instant to any object by way of experiment: —a *poker*, a *fire-shovel*, or *strong walking-stick*, for the purpose of illustration, is as good a *lever* as any that could be made. Lay a shovel across a fender, and put a large coal into it, then balance the coal with the hand at the other end of the shovel; in this situation, the shovel is a *lever*, the fender is the *fulcrum*, the coal is the *weight* or *resistance*, and the hand is the *power* to raise and overcome it.

174. The *force* with which any body moves is called its *momentum*. If a boy walk at the rate of *two* miles an hour, and go against a wall, he will strike it with a sensible *force* or *momentum*; if he walk at the rate of *four* miles an hour, and go against it, he will strike it with *double* the force; or if he run at the rate of *six* miles an hour, he will strike it with *three times* the *momentum*.

Obs.—Every child that throws a ball, or shoots a marble is sensible that its *force* or *momentum* is in proportion to its velocity; the same marble will hit twice as hard, if it move twice as fast, or ten times as hard, if it move ten times as fast. Let him

substitute the word *momentum* for hard, and ve fast, and he will at once understand the princip mechanical powers.

175. If a man, *twice* the weight of t go with the same degree of swiftness, the same velocity as the boy, he will go the wall with twice the momentum of th every instance. Hence, it is a gener which must not be forgotten, that the mo is always in proportion to the combi united size and velocity of the forces emp

Obs.—A marble, twice the size of another with *equal* velocity, will strike with twice the f this is all that need be understood. Any one learned the multiplication table, may easily *forces* or *momenta*: a ball of two pounds weig ing with a velocity of six miles an hour, will h a momentum which may be represented by t plied by *six*, producing *twelve*; and a ball wei pounds, and moving at the rate of eight miles will have a momentum equal to *six* multiplied producing 48; hence, these two balls move with momenta equal to 12 and to 48; or, in simpl one moves with four times the force of the other

176. If a stone weighing 500 pounds, raised one foot by a man, who can lift o pounds, he cannot raise it, unless he e *five* to make his arm move five feet, w stone moves only one foot; because 10 plied by *five*, is equal to 500 multiplied

177. This increase of motion in the effected by the *lever*; because the mo one end is in the same proportion to the of the other, as the distance of the two from the fulcrum.

If a lever, six yards in length, laid e

crum, at one yard from one end, and the above named stone be fixed to that end; the hand which pulls at the long, or five yards' end moves over five times the space that the other end does; consequently, though pulling but 100 pounds, it will be equal to 500 pounds at the short end of the lever.

178. The grand principle, then, of mechanics is this,—that *we gain in power, what we lose in motion*; and hence, the strength of one man could move the earth, if he could bring his strength to act upon it with such a velocity, as there is a difference betwixt his power and the weight of the earth.

Obs.—The property of the simple lever is exemplified in the steelyard used by butchers for weighing meat; and in the iron crow.

179. Single *pulleys* merely improve the purchase; but *compound pulleys* enable the hands of those who pull them, to move over *twice* the space according to the number of pulleys; once, two acting pulleys increase the power four times, and three increase it six times.

180. A force applied to the circumference of a large Wheel, as Water, Wind, and the Feet, Strength of men and horses, gains power in proportion of the diameter of the wheel to the axle.

If a water-wheel be 12 feet in diameter, and an axle of one foot, the power acting at the circumference of the large wheel, move twelve times the space which the circumference of the axle moves; hence 12 cwt. may be raised with the power of *one* cwt.

Obs.—All windlasses, cranes, mills, windmills, and intermills, are formed on this principle. The power, whatever it be, is applied to the circumference of a large wheel, whose circumference moves in consequence, per sup., ten miles an hour, while its axle, one-tenth of the diameter, moves but one mile an hour; consequently, the strength of one man at the circumference will be equal to that of ten men at the axle.

101. Inclined planes, or sides of hills, wedges, screws, jacks, &c., are all used in mechanics on the same principle; their power depends on the proportion between the *height* actually attained and the *length* of the plane moved over.

A screw is an inclined plane; and if a lever be added to it as in presses, the power gained is so great, that a man can multiply his strength many thousand times.

Obs.—If I wish to roll a cask, weighing six hundred weight, on an elevation equal to ten feet, and my force is but two hundred weight, it is obvious, above principle, that an inclined plane must be times ten feet, or 80 feet long. If a mail-coach two tons, and is drawn on level ground, by a force to eight hundred weight, and is to be drawn to the a hill which rises twenty yards in a hundred, the will have to pull with an additional force equal fifth of the weight of the carriage, i. e. one-fifth cwt., or double that with which they could draw ground.

102. A body put in motion, would not ever, if it were not for the friction of the and the resistance of the air, which is it. A fourth of all power is lost in m from Friction and Resistance: hence of oil to smooth the parts; the n smooth roads for wheel-carriages;

contrivances called friction-wheels, for
shing friction.

The principle of bodies continuing in motion
ing put into it, is felt by those who are in a car-
hich suddenly stops. They are thrown forwards,
their not parting with the motion they have re-
From this cause, when a ship in full sail strikes
k, every one on board is thrown down, and ge-
the masts snap in two; so when an open chaise
on a horse falling, those in it are thrown forward;
the position of the chaise, but owing to the mo-
ich has been communicated to their bodies.
lence also, rollers are very useful assistants in
heavy stones, or bodies, from the little friction
ate.

The principle of all the mechanical
, however they may be combined, is the
that is to say, *to create all the difference*
le between the velocity of the power, and
ocity of that body which is to be acted
on as to increase the momentum of the

of the most common combinations is
d by *cogged-wheels*; which, when turned
ne power, move greater or smaller wheels,
e new directions to the force.

A small wheel, with *eight* cogs or teeth,
g another which has *forty* cogs, diminishes
otion of the axle of the larger wheel a
and increases the power *five* times, and
the common windlass.

ne wheels are destined to effect certain ob-
without increase of power, as in clocks or
es. Sometimes, a greater power is applied
duce increased motion, as in the roasting-
nd in many mills.

Obs.— On duly considering the vast increase of by some of these combinations, it cannot be m further wonder that first-rate ships of war, and such vast objects, are easily constructed. In so stances, one man is enabled to lift up as much as and powers may be applied equal to the strengt hundred thousand men.

185. Clocks and watches are nothing than a simple arrangement of wheels of dif diameters and numbers of teeth, so as to in seconds, minutes, hours, days, and even m

Clocks are set in motion by a weight turns a cylinder, and this cylinder sets the in motion.

Watches are kept in motion by a coiled s which, in seeking to uncoil itself, exerts a that gives motion to one wheel, which tu the others.

Obs.— A lecture of ten minutes at a watch-m with the wheels and other parts under the eye, v plain more than could be done by verbal descrip a volume.

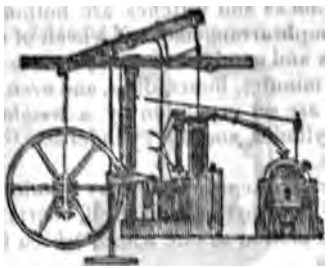
186. The triumph of mechanics is the engine. The inventor observed the exc force of steam in lifting up the stiff lid of tle as he sat at breakfast, and he and other since applied this resistless power to pro motion applicable to all kinds of machine

187. In constructing these engines, from a copper is thrown into a hollow ir linder, with a close lid or stopper, which as the steam rushes into the cylinder, and when the steam is condensed by cold thrown in for the purpose.

An upright iron rod is fixed to that li

e end of a large beam; which, in conse-
e, has an action communicated to it similar
it of a see-saw, and is lifted up and pulled
with wonderful precision and force.

THE STEAM ENGINE.



—A regular and powerful motion being thus pro-
the mechanic seizes upon it, and applies it with
all kinds of machinery. The apparatus itself has
ightly varied by different persons, and for diffe-
ffects; but the principle remains the same, and it
haps, the greatest discovery that ever was made in
ics.

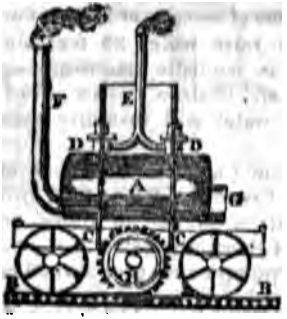
Ir. Watt, of Birmingham, has made many im-
ents in the steam-engine; and, among others, he
the top of the cylinder, working the rod through
l injects steam above as well as below, so that the
downward is produced by steam, as well as that
d; he also condenses the steam in an adjoining

One horse can, by common machinery, raise
pounds one foot high in a minute; but some steam
es perform the labour of 60 or 80 horses! A small
a ten-horse power, with the steam produced by a
bushel of coals, will raise 30,000,000 of pounds one
gh; or it will grind and dress three sacks of wheat,
d draw into rods five cwt. of iron, and drive all

the same time 1,000 cotton spindles. Steam Engi lately been applied with success, to impel b ships.

3.—Mr. Blenkinsop, of Leeds, has, with gr cess, lately applied steam to move coal-wagge rail-way, instead of drawing them with the p horses. Here is represented his machine, to w carriage may be annexed.

BLENKINSOP's MACHINE.



A. Boiler.
B. B. B. Patent Cog Rack and Wheel.
C. C. Crank Rods.
D. D. Steam Cylinder.
E. Discharging Pipe.
F. Smoke Chimney
G. Fire Door.
Scale 1-eighth of an inch to a foot.

188. The Pump for raising water is a useful machine; and its principle, wh founded on the elasticity or pressure of t should be understood. It can raise wa required, to the height of thirty-three fe the pressure of the air on the water.

Obs.—If a long glass tube, closed at one end, were deprived of air, and its open end immersed in quicksilver, the quicksilver will rise in it about 29 inches; or, if placed in water, 33 feet of water will rise in it; the weight of 33 feet of water being equal to 29 inches of quicksilver. The rise of those fluids in such a tube, is caused by the pressure of the air on the surface of the external mercury or water: hence it is inferred, and with reason, that the elasticity of the air which we breathe, is in all places equal in force to the weight of about 29 inches of mercury, or 33 feet of water.

189. To raise water 33 feet high, nothing more then is requisite than to put one end of a pipe in it, and to draw the air out of that pipe, when the water will instantly ascend in the pipe.

Such is the purpose and effect of a pump; and all that is to be done is by proper contrivances to draw out the air above, and keep up a supply of the water below.

190. A pump consists of a wooden or copper pipe, with a long iron rod to work up and down within it, by means of a handle.

At the lower end of the iron rod is fixed a metallic hoop, provided with leather to fit the pipe: in the centre of the hoop is a *little trap-door* or *valve*, which opens only upwards, and when down, shuts very close.

At the bottom of the pipe, near the water, another such valve also opening upwards, is fixed tight within the pipe itself.

191. The handle of the pump being raised, the iron rod (called the *piston*,) with its valve at the bottom of it is forced down the pipe.

valve op wa , the air in
p e.
down the , the
it the valve, aving a
een it and the lower fixed v
up the vacuum, the water rushes
ugh the lower valve.

On again raising the handle, the piston a
nds; and the water now rushes thro
valve, and, on pulling down the handle a
e piston and its closed valve *rise*, brin
p the water.

Its ascent creates a new vacuum, and
water rushes through the lower valve; the
per valve is made to descend again, to rise a
closed, and bring up water.

192. *Fire-engines*, and other *forcing-eng*
have no valve or flap fixed to the piston;
solid plate is moved up and down by it, an
rising water is thus violently driven into
joining air-tight vessel.

Through the top of that vessel, the
pipe is so inserted, that its mouth may
low the water, leaving the upper part
vessel filled with air.

Then the elastic power of that porti
forces the driven water up the playing

The energy of the stream, will of c
pend on the power applied to force
piston, and drive the water into the

Obs.—An inspection of a pump, or fire
teach more in ten minutes, than more de
many hours.

XI. *Trade and Commerce.*

193. The barter of commodities is necessarily coeval with the first formation of society. One man might have too much corn; and another too much wool; and each would be willing to give what he had to spare of his own superfluity, for what he might want of the superfluity of the other.

194. In time, such barter would become a system; otherwise, every family would have to grow every article it consumed, and to manufacture every commodity it wanted. The taylor would make clothes for the farmer, and take provisions for his labour. The carpenter would build on the same principle of reward; and hence would arise all the distinct trades which we now see exercised.

195. One farmer too would cultivate wheat; and another would make cheese and butter, according to the nature of their respective soils.

They would either exchange on the spot, or each would carry his peculiar produce to a common market, and exchange it for gold or silver, articles of universal currency, which he could exchange at any time, for whatever else he wanted.

196. The application of labour to particular or individual objects, has also tended greatly to improve every manufacture.

A man who is nothing but a taylor, is far more expert at making clothes, than if he were

nlac, a shoemaker, carpenter, and blacksmith; and still more so, if, instead of making all kinds of clothes, he work at particular parts of garments.

'This is called *division of labour*.

197. 'The utility of dividing labour is exemplified in making pins.

'Were a piece of metal given to a man to make one pin, he could scarcely do it in a day.

'In pin manufactories, however, each person through twenty-five hands: one draws out the wire, another straightens it, another cuts it, another points it, three or four prepare the head, two or three put it on, and others finish them, and put them on a paper.

'Twenty-five persons, thus, make one hundred and twenty-five thousand pins in a day; or five thousand to each person!

198. 'Labour likewise subdivides itself enormously in every branch of the elegant and useful arts.

'Thus, in building, there are, the bricklayer, the stone-mason, the architect, the surveyor, the carpenter, the sawyer, the carpenter for fine work, the joiner for fine work, the slater, the plasterer, the plumber, the glazier, the ironmonger, and the painter, all of whom carry in their several departments.

199. 'In villages and remote countries, where every separate branch could not meet with sufficient employment, the same person will often exercise two or three branches; for example, the stone-mason, bricklayer, slater, and

often united in one workman; so the carter and joiner; also the plumber, glazier, painter; and the carpenter or bricklayer es upon himself, to act also as architect and veyor. *See the Book of Trades.*

00. In the arts connected with the furnishof a house, there is the smith, the ironger, the joiner, the cabinet-maker, the look-glass maker, the frame-maker, the carpetter, the bedstead-maker, the feather-merant, the blanket-manufacturer, the oil-clother, the copper-smith, the venetian blindker, the tinman, the print-seller, the booker, and the painter; all necessary for the se of a man of taste and fortune.

01. In branches of trade connected with clothing of a man, we have the wool-man, comber, the spinner, the weaver, the fuller, dyer, the presser, the packer, and the wool-draper.

or *cottons*, there is the planter, the merant, the cotton-spinner, the weaver, the acher, the dyer, the presser, the packer, the ehouseman, and the draper.

02. In the *silk trade*, there is the importer, silk-throwster or spinner, the weaver, the r, the presser, and the mercer.

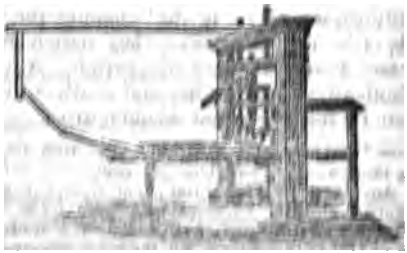
n the *iron* and *metallic trades*, called the *dware-manufacture*, there is the miner, the lter, the iron-master, the founder, the scythe-th, the button-maker, the gun-smith, the rd-blade manufacturer, the cutler, the po-

lisher, the plater, the finisher, the sorter, t
packer, the factor, and the hardwareman.

203. In connexion with books and literatu
there is the author, the designer, the publish
the rag merchant, the paper-maker, the
stoner, the type-founder, the press-maker,
ink-maker, the pelt-maker, the glass-maker,
compositor, the pressman, the gatherer,
folder, the stitcher, the leather-seller, the bi
er, the copper-smith, the engraver, the wo
cutter, the copper-plate printer, and the bo
seller: in all 25 trades, to produce the U
versal Preceptor.

Obs. 1. The author requires, too, his quill-marel
and his ink maker; the designer, various branche
trades; as the pencil maker, the colour grinder, &c.;
the rags require sorters; the paper-maker has his
men, his dryers, pickers, cutters, presses, &c. &c.;
so on in each department, extending the 25 even to 1

THE PRINTING PRESS.



204. A pack of *wool*, weighing 240 pou
employs 200 persons, before it is ready for t

in the form of stuffs, cloths, &c.; to be made into stockings, it will occupy 184 persons for a week; as 10 combers, 100 spinners, winders, &c. 60 weavers or stocking-makers, besides dyers, pressers, &c.

A sword made of *steel*, the original metal of which was not worth a shilling, is sometimes sold for 300 guineas; and a watch-chain has produced 50 guineas: the metal of which, before it was wrought, was not worth three-pence.

In like manner, a yard of Mechlin *lace* will fetch 20 guineas; the flax in which was originally not worth three-pence.

So likewise, a *painting*, not two yards square, has been valued at 25,000*l.*; and a shawl, which contains but a few ounces of wool, and may be drawn through a curtain ring, sells for 60 or 80 guineas.

205. As it is with individuals, so it is with distant nations: what one nation possesses in superfluity, it is desirous to exchange for some article it wants, with any other nation which possesses a superfluity of that article. Anciently, England had tin, wool, and coals, which it exchanged for wines and manufactures.

Obs.—A people, who have no superfluities desirable among other nations, can have no trade, nor can they enjoy any foreign commodities; but if they had such superfluities, they can exchange them, and trade. Gold or silver are superfluities which command trade, and pay the balance of trade, when the goods received exceed the goods delivered. Hence arises the wealth, in gold and silver, of all fruitful and industrious countries.

206. Such was the origin, and such is the

[illegible] as this day [illegible] the whole world, and [illegible] exchange for their [illegible] [illegible] for their [illegible] [illegible] produce, which is consumed at home [illegible] [illegible] nicians or Philistines were the first [illegible] on [illegible] ord who employed ships to carry [illegible] prod[illegible] [illegible] nufactures of one [illegible] tion to [illegible] other.

They were followed by the Carthaginians; and these, by the Venetians, Genoese, and Hanse Towns.

During the two last centuries, the Portuguese and Dutch divided the trade of the world with the English.

> Thou, gracious Commerce, from his cheerless cave,
> In horrid rocks, and solitary woods,
> The helpless wand'rer, man, forlorn and wild,
> Didst charm to sweet society; didst rust
> The deep foundations, where the future pride
> Of mightiest cities rose, and o'er the main
> Before the wond'ring Nereids didst present
> The surge-dividing keel, and stately mast,
> Whose canvas wings, distending with the gale,
> The bold Phœnician, thro' Alcides' straits
> To northern Albion's fin-embowell'd fields,
> And oft beneath the sea-observing brow
> Of cloud-envelop'd Teneriff convey'd. [illegible]

208. Within the last twenty years, preceding 1815, the British monopolized the trade of the whole world. They were not only the greatest manufacturers, but also the greatest carriers of desirable produce; and they have had three

as many merchant-vessels on the seas, as
r nations put together.

Besides trading with the remotest na-
the British have established considerable
ents or colonies in Asia, Africa, and
ca; by which means they enjoy the pro-
cultivation, in addition to those of mo-

In Asia, the British colonies are Bengal,
countries on the Ganges, the coasts of
ndel and Malabar, and the large islands
on and Sumatra.

m these and neighbouring countries,
ring to Europe spices, silk, rice, tea,
, coffee, drugs, perfumes, and precious

In Africa, the colonies of Britain are
pe of Good Hope, Goree, Sierra Leone,
rts on the coast of Guinea.

m these, they bring to Europe gold dust,
gums, and drugs.

In America, the British provinces of
and Lower Canada and Nova Scotia,
e furs, corn, and fish. In the West-In-
reat Britain occupies Jamaica, Barbadoes,
dozen other islands, besides Demerara,
ll which supply sugar, rum, cotton, coffee,
drugs, mahogany, sweetmeats, &c.

These luxuries serve at once to gratify
es, and become desirable mediums of
ge for the produce and manufactures of
r own

We send them to Russia, in exchange for h
tar, and tallow:
To Sweden, for copper:
To Norway, for timber:
To Germany, for linen rags and exquis
paper:
To France, for wine and brandy:
To Portugal, for wine:
To Spain, for gold and silver, and fruit:
To Italy, for silk, rags, oil, and fruit:
And to Turkey, for silk, drugs, oil,
coffee.

214. This amazing intercourse, in the
peace, was carried on in about 24,000 vess
all sizes, carrying three millions of tons
then, and employing 200,000 seamen.

The trade and manufactures employ, bes
from four to five millions of the people of G
Britain and Ireland; and serve, also, to e
all its inhabitants.

215. Several branches of the foreign tra
England are carried on by subscription co
nies; who divide the profits in half-yearl
yearly dividends.

These are the East-India Company; w
enjoys a monopoly of the trade to Asia:
The Bank of England; for bullion and
cious stones:
And the Hudson's Bay Company; which
nopolises the trade in furs from those coun
There are also the nearly extinct Tu
Russia, African, and South-Sea Companies

6. The inland or domestic trade of Great-ain and Ireland, is carried on by means of thousand waggons and stage-coaches; by ls and rivers, which intersect every part of wo islands; and by many hundred coast-essels, which carry the produce and manu-res of one place to another.

7. The chief ports are London (equal in to all the others), Liverpool, Bristol, gow, Greenock, Hull, Falmouth, Dart-h, Plymouth, Portsmouth, Yarmouth, Lynn, ds, Leith, Aberdeen, Whitehaven, Swansea, lin, Cork, and Waterford,

8. The chief manu turing towns are Bir-ham, Wolverhamp and Sheffield, for ry and metallic wa .
anchester, Stockp rt, Bolton, Glasgow, Paisley, for calicoes and muslins.
eds and Norwich, for woollen cloths.
ttingham and Leicester, for hosiery.
lfast and Londonderry, for linens.
ilton and Kidderminster, for carpets.
rweastle and Worcester, for china, porce-and glass.

9. The United States of America, under dvantages of a long peace, the possession w materials of every kind, numerous fine , and a free government, are rapidly ad-ing in the manufacturing system; and with erous ships at sea, the Americans are car-on an extensive trade with all parts of the d.

220. The trade of most other nation
been ruined by unwise governments, or b
litical revolutions. That of China, by i
means canals, is the greatest and most a
tageous that is carried on in any country in
but the Chinese have no general foreign t
except with Japan.

221. The exports and imports of Grea
tain have been nearly fifty millions each
annum. The worth of the various merchan
and manufactures in hand, is estimated
millions; and the value of the shipping
ployed, at about 25 millions.

222. The employments to which so v
trade gives rise, are, as far as regards the
those of the ship-owner, the ship-builde
copper-smith, the rope-maker, the bl
baker, the provision-merchant, the shi
penter, the anchor-smith, the mathematic
strument-maker, and the slop-seller.

223. In regard to the cargo of ships,
are the merchant, the ship-broker, the f
the manufacturer, the packer, and the li
man.

Among merchants, there are *Spanish*
chants, *Turkey* merchants, *Italian* merch
Russia merchants, *Hamburgh* merchants,
India merchants, *American* merchants, *
merchants, and *African* merchants.

XII. *The Art of Navigation.*

224. That art must be allowed to be curious and extraordinary, which enables men to conduct great ships with precision, across vast seas many thousand miles wide, in which they often sail for weeks together without seeing any land.

225. Anciently, and indeed till within the last 400 years, no ship ventured out of sight of land. If the mariners lost sight of the land, they gave themselves up, and it would be merely accidental if they ever regained the same shore: such were the disadvantages of Phœnician, Carthaginian, Roman, and Grecian commerce.

226. In the 13th century, it was discovered, by mere chance, that if a certain part of the ore of iron was suspended on a point, and allowed to turn itself at pleasure, it would always point to the north part of the world. Hence, if a seaman took with him to sea one of these loadstones, he was enabled to tell the north, and keep a journal of his *course*.

When from the bosom of the mine,
The magnet first to light was thrown,
Fair Commerce hail'd the gift divine,
And smiling claim'd it for her own;
"My bark," she said, "this gem shall guide
"Thro' paths of ocean yet untried;
"While as my daring sons explore
"The rude, inhospitable shore,
"Mid desert sands and ruthless skies,
"New seats of industry shall rise,
"And culture wide extend his genial reign,
"Free as the ambient gale, and boundless as the main."

PYE.

227. As the loadstone enabled him to keep an account of the course of his voyage out, so it was not difficult to retrace the same course back, by referring to his journal. If a man in the dark go 50 steps to the right, 20 straight on, and 30 to the left; he will easily return to the place whence he set out, if he takes 30 steps to the right, 20 straight on, and 50 to the left.

228. In the wide and pathless ocean, the loadstone then, by constantly pointing north ward, proves a certain guide, and enables th mariner, if he has recorded his past course, t ascertain his exact position on the sea, and shape his future course accordingly.

229. The loadstone, or magnetic needle, it is also called, is usually placed in a fra and covered by a glass. Beneath it, in the fra are marked the 32 points of the compass; is to say, the whole circle of the horizon is divided into 32 parts.

The principal of these are, the four car points, the north, south, east, and west these are subdivided into north east, north south-east, and south west, &c. &c.

Obs.—Aimed is the representation of this *the boxing or repeating* of which is among you deemed a considerable achievement.

d Portugal are a

divided into four
Ocean, ten thou-
tic Ocean, three
dian and South-
Ocean.
of water; as the

the sea that in-

ses joining one

ch we are under
light, heat, life,
whose genial in-
come a dark, so-
es in diameter;
f miles distant

f a vast system
th: all of which
se distances, in
rious seasons to
o each.

ether's centre; but
their solid parts,
in a straight line;
ther, that they neu-
uence, the planets
hich is nearly cir-

only considered
of maculæ, or

o'clock on the morning of Jan
comes to a conjunction with the
at London, and a sailor find that
tion takes place at nine o'clock wh
concludes that he is one hour, or 1
1045 longitudinal miles west. Hen
the *longitude* of the place where h

233. A Nautical Almanack is
government, expressly for the u
and is carried, in many curious pr
such a nicety, that by means of
telescope, and an accurate watch c
a sailor can now ascertain his pr
part of the seas within half a mile.

234. So expert are navigators b
days, that a ship has sailed from
to Calcutta in 55 days, a voyag
merly employed six months; from
to Malta in 11 days, formerly two
New York in 21 days, formerly t
and to the West-Indies in 21 days,
months.

Drake and Anson were three ye
round the world; and this is no
performed by merchantmen, in
months.

XIII. *Geography and Astr*

235. Geography describes the s
earth; the shape and size of the la
the boundaries of nations, and their
natural productions.

It also teaches the character of the inhabitants; their government, religion, manufactures, and mode of living; and it ought to enable us to shun their errors, and profit by their experience.

Obs.—As there are numerous works adapted for schools on this subject, and the details are very extensive and prolix, it would be trifling with the pages of this work, to dwell tediously on geography.

236. The earth, on which we live, is a round ball or globe, 8,000 miles in diameter, and 25,000 miles round. Its surface is covered with one part of *land*, and three parts of *water*, which are inhabited and filled with innumerable living creatures.

237. Of the internal parts of this immense globe little is known to us. From the surface to the centre is 4,000 miles, yet no mine is a mile deep.

As far as man has penetrated, he has found successive layers or coats of different earths; lying over each other, like the coats of an onion, or the leaves of a book.

Obs.—In digging wells, various thicknesses of different earth are found in different places, in an order something like the following: three feet of black earth, called vegetable mould, four of gravel, five of gravel and sand, six of clay, three of sea-shells, fifty feet of clay, forty of sand, five of stone, three of marl, &c. &c.; and what is remarkable, every layer is the same thickness as far as it extends, and generally parallel with the surface of the earth.—*See my Grammar of Philosophy.*

238. The highest mountains detract no more from the roundness of the earth than the inequalities on the rind of an orange detract from

its general rotundity. Chimboraço, on Andes, rears its lofty head four miles h this is but the two thousandth part of th diameter.

Obs.—Mount Blanc is not three miles high; of Teneriffe but two miles and a half; and M not two miles. Our Snowdon is not three qua mile; and but a grain of sand compared to t earth.

239. The mines, therefore, may be c to the sting of a bee in the body of phant; and the mountains to the inequ the rind of an orange; yet, vast as is t the sun, which enlightens and warms i million times greater; or, in other wo million earths united in one mass, wo be the size of the sun.

240. The land consists of two *con* the old continent of Europe, Asia, an and the lately-discovered continent of

There are also many thousand *isla* rounded by the sea; many of them, a Britain, anciently united to the contin others, the tops of marine mountains out of the sea, the bases of which ar bottom of the ocean.

241. When a point of land juts out sea, it is called a *Cape* or *Promontory* Cape of Good Hope.

When two masses of land are join ther by a narrow slip, it is called an as the Isthmus of Suez, and the Ist Panama.

A *Peninsula* is a tract of land alm

rounded by water: Spain and Portugal are a *peninsula*.

242. The waters are usually divided into four *Oceans*; the Great or Pacific Ocean, ten thousand miles across; the Atlantic Ocean, three thousand miles across; the Indian and Southern Ocean; and the Northern Ocean.

Seas are detached pieces of water; as the Mediterranean and the Baltic.

Gulfs and *Bays* are parts of the sea that indent into the land.

And *Straits* are narrow passes joining one sea or ocean to another.

243. The vast SUN, to which we are under such sensible obligations, for light, heat, life, and vegetation; and without whose genial influence all the Earth would become a dark, solid mass of ice, is 900,000 miles in diameter; and the earth is 95 millions of miles distant from it.

244. The Sun is the centre of a vast system of planets, or globes, like the earth; all of which move round his body at immense distances, in periods which include the various seasons to each, and are therefore a year to each.

Obs.—They are all pressed to each other's centre; but the action of their fluid parts against their solid parts, gives them a tendency to go forward in a straight line; and those two forces so balance each other, that they neutralize one another, and, in consequence, the planets are moved round the sun in an orbit which is nearly circular. *See* 274.

245 The Sun has been commonly considered a globe of pure fire. A number of macule, or

dark spots, may, however, by means of a te
scope, be seen on different parts of his surface

These consist of a nucleus, which is mu
darker than the rest, and surrounded by a m
or smoke; and they are so changeable as t
quently to vary during the time of observati

Some of the largest of them exceed the bu
of the whole earth, and they are often seen
three months together.

They are supposed to be cavities in the bo
of the sun; the nucleus being the bottom
the excavation; and the shady zone surrou
ing it, the shelving sides of the cavity.

THE SUN AND SOME OF HIS SPOTS.

Great source of day! best image here below
Of thy Creator, ever pouring wide,
From world to world, the vital ocean round;
On Nature, write with every beam, His praise.
Heav'n of surrounding worlds!——
Tho by thy secret, strong attractive, force,
(As with a chain indissolubly bound),

Thy system rolls entire; from the far bourn
Of utmost "*Herschel*," wheeling wide his round
Of "*eighty*" years; to Mercury, whose disk
Can scarce be caught by philosophic eye,
Lost in the near effulgence of thy blaze. THOMSON.

246. As the Sun is one million times larger han the earth, it is evident that the balance of heir mutual pressure would not be destroyed, one million of earths moved round the Sun; ut, at present, we know only of SEVEN such odies, some nearer and some farther off than he earth, and some greater, and some larger, alled Mercury, Venus, Earth, Mars, Jupiter, aturn, and Herschel.

The *Sun* revolving on his axis turns,
And with creative fire intensely burns;
First *Mercury* completes his transient year,
Glowing, refulgent, with reflected glare;
Bright *Venus* occupies a wider way,
The early harbinger of night and day;
More distant still our *globe terraqueous* turns,
Nor chills intense, nor fiercely heated burns;
Around he rolls the *lunar orb* of light,
Trailing her silver glories through the night.
Beyond our globe, the sanguine *Mars* displays
A strong reflection of primeval rays;
Next belted *Jupiter* far distant gleams,
Scarcely enlightened with the solar beams;
With four unfix'd receptacles of light,
He towers majestic through the spacious height:
But farther yet, the tardy *Saturn* lags,
And seven attendant luminaries drags;
Investing with a double ring his pace,
He circles through immensity of space.—CHATTERTON.

247. Some of these several globes, so revolv- ng to receive light and heat from the sun, erve as centres to other minor globes called *oons*. These satellites accompany the planet

in its tour round the Sun; serving to balance motions, and to reflect by night the Sun's li on the planet for the use of the inhabitants.

248. The earth has *one* moon, 2,000 miles diameter, and a quarter of a million of m distant from the Earth.

Jupiter, another planet, has *four* moons.

Saturn *seven* moons; and he is also surrounded by a *large double ring*, 30,000 m distant from his body.

And Herschel has *six* moons.

249. But if the matter of all these pla and moons were put together, they are equal to a ten thousandth part of the Su or rather, it would require ten thousand m masses to make up the bulk of the Sun.

250. Besides the *seven* planets, and th *eighteen* moons, there are *four* very small bo called *Asteroids*, which move round the S between the orbits of Mars and Jupiter, cal Ceres, Pallas, Juno, and Vesta, all of them l discoveries.

251. There are also a multitude of bod some as large as the earth, called *Comets*, wh exhibit very peculiar phenomena of the S The Planets move round him in orbits nea circular, but Comets almost touch the Sun one part of their orbit, and then stretch into spaces thousands of millions of miles.

THE COMET OF 1680.

THE COMET OF 1811.

Fast thou ne'er seen the comet's flaming light,
Th' illustrious stranger passing, terror sheds
On gaining nations, from his fiery train
Of length enormous; takes his ample round
Through depths of æther; coasts unnumber'd worlds
Of more than solar glory; doubles wide
Heaven's mighty cape; and then revisits earth,
From the long travel of a thousand years. YOUNG.

52. The twinkling stars, of which we see so
ay every clear evening, do not belong to our
ar system; but are themselves so many Sunr
other systems like ours.
Each Star is supposed to be the centre of its
wn system; and to have planets, moons, and
omets moving round it at immense distances,
ike those of our solar system!

Bright legions swarm unseen, and sing, unheard
By mortal ear, the glorious Architect,
In this his universal temple, hung
With lustres, with innumerable lights,
That shed religion on the soul; at once,—
The temple and the preacher! O how loud,
It calls Devotion! genuine growth of night
—Devotion! daughter of Astronomy!
An undevout astronomer is mad.

253. They are called *fixed stars*, becau
they never appear to move; and are so dist
that although the orbit of the Earth is
93 millions, or 186 millions of miles acr
and we are consequently 186 millions of
nearer to some stars at one time than w
at another, yet the stars always appear
same places.

Oh Nature! all-sufficient! over all!
Enrich me with the knowledge of thy works!
Snatch me to heaven; and show thy wonders t
World beyond world, in infinite extent,
Profusely scatter'd o'er the blue immense.

254. The distance of the nearest of t
stars cannot be less than 32 billions o
and all of them are doubtless as far dis
each other.

They appear to fill infinite space in
VAST systems of stars; and our Sun is

be one of that amazing shoal of stars, whose riads form the bright cloud of light called Milky Way.

low distant, some of the nocturnal suns!
o distant, says the sage, 'twere not absurd
o doubt, if beams, set out at Nature's birth,
.re yet arrived at this so foreign world;
hough nothing half so rapid as their flight.
.n eye of awe and wonder let me roll,
.nd roll for ever. Who can satiate sight
n such a scene, in such an ocean wide
f deep astonishment? Where depth, height, breadth,
.re lost in their extremes; and where, to count
he thick-sown glories in this field of fire,
'erhaps a seraph's computation fails. YOUNG.

155. The stars, as seen through a telescope, infinite in number, more than 100,000 have :n reduced to a catalogue; but with the ted eye, not more than 6 or 800 stars on the irest night can be seen;—so deceptive is the earance when viewed hastily.

156. The ancients, in order to find and de-ibe the stars, classed them into figures of n and beasts, called Constellations, and re were fifty of these. The moderns have led twenty-four others; so that the celestial be, in which the stars are accurately laid wn as in the heavens, is covered with the ures of these imaginary constellations.

157. In the Zodiac, or part of the heavens ere the Sun appears to move, there were elve of these constellations: as,

Aries, the Ram ..... ♈
Taurus, the Bull ..... ♉

Gemini, the Twins . . . . . ♊
Cancer, the Crab . . . . . ♋
Leo, the Lion . . . . . ♌
Virgo, the Virgin . . . . . ♍
Libra, the Balance . . . . . ♎
Scorpio, the Scorpion . . . . . ♏
Sagittarius, the Archer . . . . . ♐
Capricornus, the Goat . . . . . ♑
Aquarius, the Water Bearer . . . . . ♒
Pisces, the Fishes . . . . . ♓

On the earth's orbit, see the various signs:—
Mark where the Sun, our year completing, shines
First the bright *Ram* his languid ray improves;
Next glaring wat'ry thro' the *Bull* he moves;
The am'rous *Twins* admit his genial ray;
Now burning, thro' the *Crab*, he takes his way;
The *Lion*, flaming, bears the solar power;
The *Virgin* faints beneath the sultry shower.
Now the *just Balance* weighs his equal force;
The slimy *Serpent* swelters in his course;
The nobled *Archer* clouds his languid face;
The *Goat* with tempests urges on his race;
Now in the *Water* his faint beams appear;
And the cold *Fishes* end the circling year.

Obs. 1.—These constellations were of Egyptian invention; and the characters (which it is need less to learn) are Egyptian hieroglyphics, or rude paint ings representing, or some known emblem things.

2.—The signs of the Zodiac, in which the sun planets move, may also be recollected by means following lines:—

The ram, the bull, the heav'nly twins,
And next the crab, the lion shines,
The virgin and the scales:
The scorpion, archer, and sea-goat,
The man that holds the water-pot,
And fish with glittering tails.

268. The most showy of the constellations is rion, distinguished by his belt of * * * in a row;

neath these is Sirius, the brightest of the irs; and above, to the right, are the red star the Bull, and the Pleiades or Seven Stars; d to the left, two bright stars, Castor and llux.

These bright constellations are always visi- on a winter's evening.

Obs.—The student of Nature, who takes *an evening's* k to admire the magnificence and the glory of the rry heavens, and desires to profit by his observations, uld learn to class the heavens into particular divi- ns; and fix on certain points, as landmarks, to direct attention.

By knowing the part of the heavens in which the Sun s, he is able to determine the *eastern* side; by attend- to its situation at *noon*, he ascertains the *south*; and noticing the place of its setting, he determines the *tern side* of the horizon. He need not be told that the *th* is opposite to the *south*.

The moment, then, in which he casts his eyes on the rkling expanse of heaven, he is supposed to be sen- le of the bearings of the cardinal points, *north*, *south*, t, and *west*.

The next principle to be recognised is, that he sees ove his horizon,* one half of the whole heavens; that is say, one-half of the heavens are always visible, or ove the horizon, and the other half is below the hori- n. He must not expect, therefore, to see all the con- llations and planets at once; but only that half which the time of observation, is above the horizon.

For the sake of precision and accurate reference, nonomers have supposed the 360 degrees, into which

* The *horizon* is the line all around where the sky and the earth m to meet. The *zenith* is the point directly over head, 90 de- es from the *horizon*.

geographers divide the surface of the earth, to
tended to the heavens; so that the whole circumf
of the horizon of the heavens is supposed to be 3
grees, or proportional parts; half is 180 degrees,
quarter is 90 degrees. And as we see one-half
heavens above the horizon, it is of course 180
from one side of the horizon, in a line passing o
heads, to the side directly opposite; and of cours
the point over our heads, called the *zenith*, it is
grees to the horizon on every side.

Remember, then, that the whole heavens are 3
grees, or proportional parts round, and that fr
point directly over head, it is always 90 of these
down to the horizon.

An observer of the heavens will discover the p
sion of the whole, from east to west, by a quarter
hour's attention. Let him bring a star, in any p
tween the zenith and the southern part of the h
into apparent contact with the end of a house,
or other fixed object, and he will in a few minut
ceive the motion of that star, and of the whole h
from east to west.

It may be proper for the student now to consid
this general motion of the whole heavens is merely
rent; and is occasioned by the rotation of the e
its axis in a contrary direction. Of course, if the
tator is moving on the earth from west to east,
tant stars will appear to move from east to west.

The rising and setting of all the distant heave
dies will, hence, be easily understood. The earth
completely round every twenty-four hours: every
bitant of it will, therefore, be carried round towa
the bodies out of it, and distant from it, every t
four hours. Hence, the rising and setting of the
the succession of day and night; and all the dep
phenomena.

This progression of the whole heavens from
west; the rising of some stars in the east, and the
of others in the west; are objects which, viewed
manner, will leave impressions much stronger th
mimic representation of the same phenomena on

lestial globe. The immensity of the great vault of h
ven, the still, solemn, uniform motion; the accompan
ing association of the immeasurable distances, the app
rent perpetuity, and the countless numbers of the sta
will fill the mind with reverence and devotion towar
the omnipotent, infinite, and eternal Author of th
whole!

Having thus obtained ocular demonstration of the
motion of the stars from east to west, or rather of the
motion of the earth in the contrary direction, it will then
be necessary to attend to another circumstance which is
a consequence of that motion.

A slight consideration will evince, that the stars immed
diately above the axis on which the earth may be supp
posed to turn, will appear to remain stationary over
those places, at both ends of the axis. In turning
wheel on a fixed axis, all the parts of the circumference
will successively present themselves to different objects,
but the axis will continue to point to the same place.
If the wheel be supposed to be a globe revolving on a
axis, the effect will be the same; the point of the axis,
called the pole of the globe, will point to the same spot,
while all the parts will perform smaller or larger cir
cles in proportion as they are removed in a greater or
less degree from the poles.

It is important, then, to be able to determine the
stars in the heavens which are opposite to the poles o.
the earth; these always appear to stand still, while the
other stars appear to make a daily circuit round them.
It is however, *we can only see 90 degrees in the heavens*
in the point over our own heads, the inhabitants of no
part of the earth can see both poles, except those who
live at the equator, from which both poles are distant
ninety degrees. The poles of the heavens may therefore
be seen at the equator, exactly in the horizon, in the
north and the south; but if you travel or sail one degree
to the north of the equator, so as to be within 89 degrees
of the north pole, you will, of course, see one degree
beyond the north pole, and not so far as the south pole
by one degree; because, as before stated, you can al-
ways see 90 degrees in the heavens, from your zenith,

or place over head. In England, which lies betwee
and 60 degrees from the equator, or within 30 or 60
grees of the north pole, we always see 30 or 60 deg
beyond or below the north pole; or, in other wo
the north pole in the heavens, or the stars immedia
over the north pole of the earth, will be 30 or 60
grees high.

Rather above mid way between the horizon and
zenith, in this northern part of the heavens, we who
in England must look for the north pole of the heav
or the part which never appears to move. It hap
that there is a star so near the north pole, that for
ordinary purposes it may be taken for the north
itself; and this star may always be found very easily
means of two other stars which point to it in a right
During the winter months, these stars, which are in
constellation of the Great Bear, are to be found with
other stars of that remarkable constellation, on the eas
side of the pole. They are about *six* degrees asunder,
the nearest is five times that space, or *thirty* degrees
the polar star, at which they seem to point, and
thence, called the *Pointers*.

The north pole star being thus found, it will
pleasing employment to observe, that all the stars ap
to move round it, according to their several distan
while it constantly stands still. An hour's contempla
of this star, and of the motions of the rest of the heav
while it remains an immoveable centre, will teach
to the unlearned in astronomy, than a thousand lec
or lectures in the closet.

On a winter's evening, the other remarkable ob
in view, will be the *Pleiades*, or *seven stars*, in the so
east; and below them, a little to the east, the grand
stellation of *Orion*: and still lower, the dog star *Si*
the brightest of all the fixed stars. The three bright
together in a line, called the Belt of Orion, are at a
equal distances from the Pleiades and Sirius; th
about *twenty five* degrees from each. Besides remem
ing this distance, and that of the *Pointers*, before
tioned, for the sake of occasional comparisons, i
be useful to recollect, that the most northern of the

stars in the Belt of Orion, is exactly over the equator so that from that star to the north pole star is exactly ninety degrees.

The *Pleiades* are in the Zodiac, on the south side; and so is the red star *Aldebaran*, near them; and the two bright stars about *forty* degrees to the left, called *Castor* and *Pollux*, or the Twins, are also in the Zodiac, and about *five* degrees north of the Sun's place, on the 12th of July.

On such an evening, the Milky-Way will be seen in the west, as a light cloud; supposed by some to be formed of a mass or shoal of stars, almost infinite in number, but indistinct from their distance; though others suppose it to consist of a luminous space, and not of stars.

A celestial globe, rectified to the day and hour, will point to other objects; an ephemeris will indicate the names or places of the planets which may then be above the horizon; and any telescope will render visible many other interesting and wonderful phenomena.

Should the Moon be visible, the motion in her orbit may be nightly traced by her approximating to, or receding from, certain stars; and the same may be observed in the motion of the planets in their orbits.

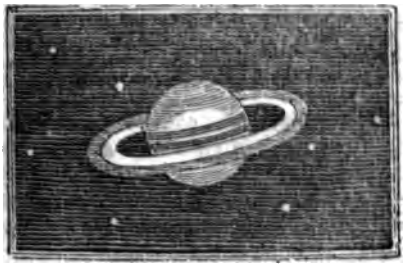
The morning and evening stars are the bright planets, Venus and Jupiter, so called from their rising or setting with the Sun. Mars is red; Saturn of a leaden colour; Herschel is so distant, and Mercury is so near the Sun, that they can seldom be seen but with a telescope.

ENUS, AS SEEN THROUGH A TELESCOPE.

Very small telescopes will shew most of the cele
phenomena; Jupiter's moons, Saturn's ring, the m
like phases of Venus, the Pleiades, the luminous
in the sword of Orion, the Spots in the Sun, a
mountains in the Moon, may all be seen with such
scopes as are bought for ten or fifteen shillings.
made all his great discoveries with a telescope
ten inches long, and which magnified only ten or
times.

JUPITER, HIS MOONS AND BELTS.

SATURN, HIS MOONS AND RING.



259. The stars, according to their distances, re of seven sizes, called *first* magnitude, *se- nd* magnitude, &c. down to the *seventh* mag- itude, which can only be seen with a telescope he stars may be distinguished from the planets y their twinkling; whereas the planets have steady light.

Obs.—Having now acquired some knowledge of the onderful things around the EARTH, which surpass the onception or imagination of man, we will return again to it, observing, that these fixed stars and other celestial bjects are constantly made use of to determine the rela- ve situation of places; and that they are unerring uides both in regard to time and place.

260. Besides the motion round the Sun in heir respective years, the earth and the planets lso turn round on their own axes and by turn- ng to and from the Sun, produce to their inha- itants, alternate light and darkness, or day and ight; so that their seasons and years are pro- uced by the grand revolution round the Sun;

and their days and nights by turning a
own axes.

Obs.—If a boy throw a ball out of his hand
going forwards, it turns round on its axis, and
precise motion of the earth and planets. So th
ball of a billiard-table moves onward, and also
its axis.

201. The distances of the seven
planets from the Sun, in round millions
Mercury ☿ 36, Venus ♀ 68, Earth
Mars ♂ 144, Jupiter ♃ 496, Saturn ♄
Herschel ♅ 1,800 millions of miles f
Sun.

Their diameters are respectively 3, 8,
79, and 35 thousand miles.

And their periods of revolution are
22, 144, 340, and 1000 months.

202. In their grand orbits, the planet
move exactly in the same level or pla
each moves regularly in its own level.
their axes exactly perpendicular to the
their orbits, but variously inclined;
inclination produces the difference of t
sons, and the different lengths of
night.

203. The whole earth is calculated
times heavier than water; the Sun
and Herschel about the weight of wate
cury nine times, and Venus six times
In this way, taking matter for matt
found, that it would take a million of ea
to make a body equal to the Sun.

204. Next to the Sun, the Moon th
the heavenly bodies, which the most

ar eminency. She is but 240,000 miles distant om the earth, only 2,000 miles in diameter, nd 6,300 miles in circumference. She ac-ompanies the Earth in its annual orbit; and, uring that period, goes herself nearly thirteen imes round the Earth in an orbit of her own.

285. The Moon goes round her orbit in 27 ays 8 hours; but, as the Earth moves forward uring the time, it is 29 days 12 hours before e returns again to a conjunction with the Sun. he Earth is sixty times larger than the Moon; r it would require sixty moons to make up the alk of the Earth.

286. The mountains in the Moon are, how-ever, higher than those on the Earth. For ex-ample, Mount Leibnitz, in the Moon, is five iles high, which is a mile higher than Chim-borazo, in Peru. The surface of the Moon is, sides, covered with deep pits or vallies, some fthem four miles deep.

THE MOON, AS SEEN THROUGH A TELESCOPE.

267. The Moon always keeps the sam towards the Earth, so that she turns once c axis as she moves round the Earth; and he and night are, consequently, as long as th riod from new moon to full moon. Bu Earth acts also as a moon to her, being a same time far more luminous: so when new moon to the Earth, it is a full earth t Moon, and the contrary.

268. As the Moon shines with no ligh sides that which she reflects from the Su is evident, that the shape must depend o position in regard to the Sun and Earth

When the Earth is exactly in the middl whole illumined side of the Moon will be to the Earth, and it will be a full moon.

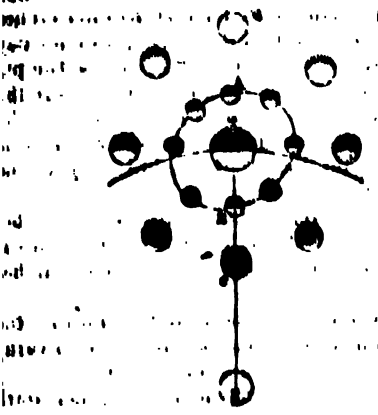
When the Moon is in the middle, her side will be presented to the Earth; and be new, or no moon.

As she proceeds from new to full, mo more of her light side will appear, or i increase; and on going from full to new, i of course, decrease.

——The Moon, refulgent lamp of night,
O'er heaven's clear azure spreads her sacred lig
When not a breath disturbs the deep serene,
And not a cloud o'ercasts the solemn scene;
Around her throne the vivid planets roll,
And stars unnumber'd gild the glowing pole;
O'er the dark trees a yellower verdure shed,
And tip with silver every mountain's head;
Then shine the vales; the rocks in prospect rise
A flood of glory bursts from all the skies;
The conscious swains, rejoicing in the sight,
Eye the blue vault, and bless the useful light.

POPE'S I

THE MOON'S PHASES.



EXPLANATION.

⊕ is the Sun; T the Earth; the inner circle represents
Moon in its orbit receiving its light from the Sun.
outer circle is the portrait of the Moon in each ad-
ing part of her orbit as seen at the Earth. Thus at
is full moon, or all light, as at a; and at E it is new,
all dark, as at e. At E it is in a position to produce
eclipse of the Sun, or overshadow the Earth; and at
to be eclipsed itself, or receive the Earth's shadow.

288. As both Earth and Moon cast long shadows, it is evident, if they moved on the same level, that every time the Earth passes between the Sun and Moon, the Earth's shadow would fall on it, and darken or eclipse the Moon; and that every time the Moon passes between the Sun and Earth, the Moon's shadow would eclipse the Sun.

270. The Moon, however, ascends and descends five degrees in every revolution, so that in general the shadows pass under or over; but when the new or full moon take place at the very time she is passing the plane of the Earth's orbit, in ascending or descending, then the striking phenomena of an eclipse take place.

271. The shadow of the Earth, as seen on the Moon, demonstrates its rotundity; and the shadow of the Moon on the Earth, proves that it is nearer than the Sun; so the passing of the Moon over planets and stars, called Occultations, proves that they are more distant than the Moon.

272. Occasionally, Venus and Mercury, the two planets nearer to the Sun than the Earth, pass over the surface of the Sun like black spots, called *transits* of Venus and Mercury.

This proves that those planets are nearer to the Earth than the Sun; and, by observing the progress of the transit at different parts of the Earth, we can obtain the measure of an angle, by which we can determine the exact distance of the Earth from the Sun.

273. Having ascertained, by means of the observation of a transit, the distance of the Earth from the Sun, the distances of all the other planets are determined by that law of nature, which exactly proportions *the cubes of the distances of the planets, to the squares of their respective periodical revolutions.*

274. Besides affording us light, the Moon affects the waters, and causes high tides

obey her influence, as the seas pass be-
ber. But as she moves forward in her
2 or 13 degrees every day, and conse-
y passes over every sea 50 minutes later
ıy than the day before, so the time of
ater is always 50 minutes later each fol-
day.

.—The tides, according to the theory of NEWTON,
ed by what he calls the *attraction* of the Moon and
it, according to Phillips, they are phenomena of
caused by the rotation or motion of the earth.
ıs such terms as *attraction* and *repulsion* ought
e received as expressive of *causes*, we shall pro-
ıystem which explains, or professes to explain,
es, and omit that which, while it affects to de-
he cause, in truth only *defines* the phenomena.
f, says Sir R. Phillips, the Earth were composed
matter only, there could be no tides; and if of
tter only, there could be no tides; because in
case would there be any *variable* transfer of mo-
he several parts: but as it is composed of fixed
fluid matter, intercepting each other (as the two
ntinents intercepting the two great seas,) so a
communication of motion arises between the
d fluid, and hence the tides of the seas.
he tides, he says, are but oscillations of the great
f the ocean, between the continents and islands
ts. The waters serve, in truth, as a species of
wheel, or pendulum, to the earth, each stroke
six hours continuance, and its length from 30
les, according to the velocity.
he connexion of the moon and the sun with the
ascribes to the operation of the same uniform
hat is of *transferred motion*,) on the whole, a
cause which operates on a system of bodies, pro-
ecessarily simultaneous effects.

The Sun and Moon concur in varying the
s; hence, we have high or spring tides.
heir actions concur at the new and full
and low or neap tides, when the forces

act in opposite directions, as at the [illegible] or when the moon is half way betwe[en] junction and opposition.

Obs.—On small seas not readily communicating with others, and on which the rotary forces act generally, and produce but one wave, there is no appearance of tides.

276. All the terrestrial phenomena, and all the problems on the globes and maps, may be reduced to one general principle; that the Sun always illuminates *one half* of the earth, and that the *other half* is in darkness; and that, from every part of the earth, we always see *one half* of the heavens, the *other half* being invisible.

277. The circumference of the earth and heavens is supposed to contain 360 equal parts or degrees; consequently, half a circle, or half the heavens, is 180 degrees, and a fourth 90 degrees. On the surface of the Earth, each degree is 69 miles; but the actual size of a degree, as carried out to the heavens, is indefinite, because space is without bounds.

278. Hence, if the Sun illumines half the Earth, he illumines 180 degrees of the Equator, or 90 degrees every way, from the place over which he is vertical. Hence, also, it is 180 degrees from the north to the south pole; and 90 degrees from each pole is the middle of the Earth, called the *Equator*.

279. Hence, as half the heavens are always visible, 180 degrees are visible, and from any point over head, it will be 90 degrees to the horizon, while the earth and the heavens [illegible]

the eye to meet, called *the Horizon*. Hence, also, an inhabitant of the equator can see the stars as far as each pole; i. e. he can see 90 degrees each way.

280. The inhabitants of the poles can see the stars as far as the equator, and no further; i. e. they can see 90 degrees. When the Sun is vertical over the equator, he shines as far as each pole: because he shines 90 degrees from the place where he is vertical, or over head.

281. Also, when the Sun is vertical 10 degrees north of the equator, he shines 10 degrees beyond the north pole, and his rays do not reach the south pole by 10 degrees; and when he becomes vertical 23½ degrees north of the equator, he shines 23½ degrees beyond the north pole, and 23½ degrees short of the south pole.

282. In its annual orbit, the Earth ascends 23½ degrees above the level of the equator, and descends 23½ degrees below. Hence, when it is at the highest point above, the Sun will be vertical over that part of the globe which is 23½ below the equator, and when below, the contrary.

Obs.—The terms above and below, up and down, relate merely to the feelings and sensations of human beings. In nature, there is no up or down, or above or below. The earth is round, and all bodies fall towards its centre; because, according to Sir R. Phillips, they perform rotations inversely as their density, or seek to exhibit equal momenta in revolving with the mass. All men, and every thing called upright, stand in a straight line towards the centre of the earth; with the earth beneath their feet, and the heavens, which surround the earth, over their heads. We usually place the south pole downward, but the inhabitant of the south pole, like him at the north pole, stands with his feet towards the centre

of the earth, both having the ...on over-head. The inhabitants of New South Wales ... the Antipodes to us in Great Britain, standing with their feet towards ours, and their heads in opposite directions; each of them wondering how the other stands; but the earth is the centre or headstone of all its inhabitants; and in nature up and down are merely relative terms.

9.—It is usual for authors to talk about the inclination of the axis to the orbit, its parallelism, &c. &c.; but as I consider the ascent and descent in the plane as more simple, and more accordant with the phenomena, although it is a mere change of terms, I prefer my own explanation to that generally adopted, particularly in aid of the tutor, if he should amuse his pupils by passing a globe round a candle, to shew the change of the seasons. The idea of an inclination of the axis I consider a vulgar error. The moon ascends and descends in its orbit about 5½ degrees, but no one ever talked of the inclination of the moon's axis to the plane of its orbit!

8.—The obliquity or angle of the orbit diminishes at the rate of a minute in 110 years, and a degree in 6,6... years. Observations were made in China 2,000 years ago, by which it appears, that the obliquity was 24°; but it is now only 23°, 28',—a wonderful confirmation, and a proof, at once, of the diminution and observation.

288. It must be evident, that during all time the Sun is vertical north of the equator will shine as many degrees beyond the north as he is vertical north of the equator; and during all the time he is vertical to the of the equator, he will constantly illum many degrees beyond the south pole.

Obs.—As it is ninety degrees from the equator pole, and as the Sun shines ninety degrees from where he is vertical, he must of course shine as grees beyond either pole as he is degrees advanwards it from the equator. If I ...an read an ninety yards off, and I advance 5½ nearer ... could I read it if it were now placed

further. The understanding of this single proposition, is all that is needful to comprehend the phenomena of the seasons, and the various lengths of day and night.

284. The Earth, in its diurnal rotation, carries every place round in a circle which is equidistant from the equator; and all places which are exactly the same distance from the equator, are carried round in the same circle.

Distance to the north or south of the equator is called *latitude*; and of course, if the Sun shines vertically at 10 degrees north of the equator, all places having 10 degrees of north latitude will pass exactly under the Sun on that day.

285. As the Sun, when vertical 10 degrees north of the equator, shines 10 degrees beyond the north pole, and 10 degrees short of the south pole, it is evident that during that rotation of the Earth, no place within 10 degrees of the north pole can turn out of the sun shine, so that to them it will be all day; and that no place within 10 degrees of the south pole, can turn into the sun shine, so that to them it will be all night.

286. When the Sun is vertical over the equator, he will then, of course, shine exactly as far as each pole, and the boundary of day and night will cut all the circles made by the diurnal rotation of every place, into two equal parts; so that the day part of the circle being equal to the night part, the days and nights will then be equal all over the world.

287. The Sun is vertical over the equator on

the 21st of March; and the Earth descends in its annual orbit for 91 days, till the 21st of June, when the Sun is vertical over all places 23½ degrees north of the equator; so that, during the 91 days, the Sun gradually gains that 23½ degrees, and has been successively vertical over all countries within that distance of the equator.

229. During the same time, he has successively shone, by similar gradual advances, as many degrees beyond the north pole, and afforded to those countries perpetual day; and of course, an increased length of day, to all places in the northern hemisphere, in proportion to their proximity to the pole, in consequence of his shining over the larger part of their diurnal circles.

230. The opposite phenomena will, necessarily, take place in the southern hemisphere of the Earth. The Sun's rays will fall short of the south pole as many degrees as he advances above the equator, and the country round the pole will be involved in darkness; and the nights will increase in length, in the same proportion as the days increase in the northern hemisphere.

Obs.—All this will be made evident, by hanging a round body somewhat below the level of a fire or candle. It will be seen, that the light shines over one pole, but does not reach the other. If then, the ball be turned round, it will be observed, that the circles performed by any parts of the surface are unequally divided by the light; and that it will be constant day near the illuminated pole, and that all the phenomena will be reversed in the other, or lower hemisphere.

. When the earth has so ascended in its as to render the sun vertical 23½ degrees of the equator, it then begins to descend after the same rate; and in 91 days, viz. st of September, the Sun becomes verti- ain over the equator.

: earth, however, continues to ascend in oit by successive gradations; till, on the f December, the Sun becomes vertical at :grees south of the equator, rendering it nt day at the south pole, and reversing e phenomena which were experienced, he was vertical 23½ degrees to the north.

. The earth then gradually descends in oit till the 21st of March, when the Sun vertical over the equator, and inclining ls neither of the poles, the days, of course, ual in each hemisphere; and *spring* is ing in the northern hemisphere, and *au-* in the southern.

Nature through, 'tis revolution all;
hange, no death. Day follows night, and night
lying day. Stars rise, and set, and rise.
i takes th' example: see, the Summer gay,
her green chaplet and ambrosial flowers,
ps into pallid Autumn. Winter gay,
ld with frost, and turbulent with storm,
s Autumn and his golden fruits away;
melts into the Spring. Soft Spring, with breath
nian, from warm chambers of the south,
lls the first. All, to rellourish, fades;
a wheel, all sinks, to re-ascend:
em of man, who passes, not expires. THOMSON.

. The heat of summer is produced by two ; first, by the greater intensity of the

Sun's rays, owing to their falling with
perpendicularity and density; and see
the excess of the length of the days
of the nights; so that the heat imbib
day is not wholly parted with during

Obs. 1.—The effect of obliquity, in regar
will be evident, if a board be held perpendic
fire a fire. It will then receive a body of ra
its breadth. But if it be placed obliquely, at
45 degrees, then only half the rays will fall on
and the other half will pass over it. So it is w
face of the earth in summer and in winter.

2. The increased heat in the polar regions
ly great, owing to six months' continued
melts, or nearly, the ice and snow, produced
six months' night. Hence, in northern count
the day lasts 16 and 20 hours, or where the S
the horizon for any number of days together,
the summer is equal to that of any part of the

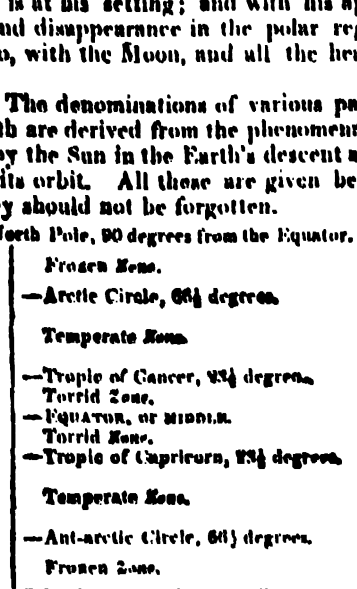
290. The air which we breathe, and
we live, just as fishes live in water,
the whole earth, to the height, as is sup
40 miles. It is of a *blue* colour, and
gives that colour to the heavens. Th
of the Sun's rays through it, is suppo
nerate part of their heat, as well as th
on the ground and on various bodies.

294. The solar heat is supposed, is
be excited, chiefly, by its action on
bodies; it being found, that in the h
mates, snow and ice lie unthawed all
on the tops of mountains; and that
is, in a considerable degree, in prop
the height of the situation, or to the
imbibed by the surrounding atmosph
the objects in contact.

295. As the rays of light are turned out of their course, or refracted half a degree when they enter the atmosphere, the Sun's rays, when they reach the earth, represent him a degree higher than he is; and, as he is a degree in diameter, he appears just above the horizon, when, in reality, his upper edge is just touching it.

So it is at his setting; and with his appearrance and disappearance in the polar regions; and also, with the Moon, and all the heavenly bodies.

296. The denominations of various parts of the earth are derived from the phenomena produced by the Sun in the Earth's descent and ascent in its orbit. All these are given beneath, and they should not be forgotten.



297. The space between the tropics, twice

23½ degrees wide, is called the Torrid Zone, from its extreme heat; the spaces within 23½ degrees of each pole are called the Frozen Zones, from the length and frigid nature of their winters; and the two spaces between the hot and cold zones, are called the Temperate Zones.

298. Such are the divisions of the earth, arising from the phenomena and effects of the Sun, the source of Light, Heat, and Life. They give rise to all the varieties of climates, productions, colour, and habits of man; and are, therefore, the key to a further and more correct knowledge of his habitation, the Globe of the Earth.

GEOGRAPHY.

299. The natural divisions of the earth int lands and waters have already been notice The other great divisions, founded on loc views only, are called EUROPE, ASIA, AFRIC and AMERICA, commonly called the four qu ters of the globe; each quarter is divided i kingdoms; and each kingdom into provinc principalities, or counties.

300. This last division gives national den nations to men; but the climates or zone their colour or character. These divide into at least six varieties, produced by h and the effects of heat and cold during a of ages.

I. *The dwarfish inhabitants of the* regions.

II. *The flat-nosed, olive-coloured tawny*

The blacks of Asia, with European fea-

The woolly-haired negroes of Africa;
The copper-coloured native Americans, lack hair and flat noses;
The white European nations.

Man is at the head of the animated crea- and unites all the advantages of strength, , and structure, which are but partially sed by other animals. His Creator has dowed him with the faculty of reasoning, th the power and will to adapt all the contrivances of other animals, to his own and luxuries.

. Man supports his body erect; and his rned towards the heavens, displays the r of his nature. His soul is painted in his ; and his majestic and resolute step an- es the nobleness of his rank. His arms ands were not given him for support, but ond the intentions of his will, and to to his purposes all the gifts of nature.

. What animals effect by natural instinct, effects by invention and by combined . Birds build their nests, bees frame ells, and beavers construct their habita- with unvarying uniformity; but the of man possess every possible variety; ford evidence of his possessing a mind and istinct from the body.

—Man, however, disgraces his intellectual cha- by engaging in frequent wars of aggression, mad ambition. Nor are such wars confined to the

savage tribes of his species; but are often wantonly and lightly engaged in, by nations that boast the highest civilization.

304. Men are to be found, however, in every stage of improvement. In England, in France, Italy, Holland, Germany, and some other European countries; in India, China, and some other Asiatic nations, they appear to approach towards the summit of their powers; but in Africa, America, and Siberia, the inhabitants are still in a state below that in which the Romans found the Britons two thousand years ago.

305. Men, in point of natural intellect, is nearly equal in all countries; notwithstanding the differences of colour and gradations of civilization. These differences are the effects of climate, habit, and education; and there is little doubt, but the whole human race sprung from one stock, as recorded in the Scriptures.

306. Considering man, as we find him, [illegible] tered over the earth, the Laplanders, the [illegible] maux, the Samoides, the Greenlanders, the [illegible] Zemblans, and the Kamschatkadales, a[illegible] to be of one family, inhabiting the [illegible] frigid zone.

Vast regions, dreary, bleak, and bare!
There, on an icy mountain's height,
Seen only by the moon's pale light,
Stern Winter rears his giant form,
His robe's mist, his voice a storm;
His frown, the shivering nations fly,
And, hid for half the year, in smoky caverns,

ICE-MOUNTAINS, &c. OF THE FRIGID ZONE.

307. No inhabited land has yet been discovered in the southern frigid zone; but the climate and habits of living, the effect of climate, render all the inhabitants of the northern frigid zone of a deep brown colour approaching to blackness. Their statures are shrunk by cold to a diminutive size; and their countenances are as hideous, as their manners are savage.

308. Their usual height is four feet, and the tallest are not above five feet; their voices are thin and squeaking; their heads large; their cheek-bones high; their eye-lids drawn aside; their mouths large; and their lips thick, and turned outward.

Obs.—Yet, they account themselves the handsomest and most civilized people in the world; and the Greenlanders, when they compliment a stranger, say, He is almost as well-bred as a Greenlander.

The following is Dryden's description of the Polar regions:

The sun from far peeps with a sickly face,
Too weak, the clouds and mighty fogs to chase;

Swift rivers are with sudden ice constrained;
And studded wheels are on their back sustain'd
The brazen caldrons with the frost are flaw'd;
The garment stiff with ice at hearths is thaw'd.
With axes first they cleave the wine; and thence
By weight, the solid potions they dispense.
From locks uncomb'd, and from the frozen beard
Long icicles depend, and crackling sounds are h
Meantime, perpetual sleet and driving snow,
Obscure the skies, and hang on herds below.
The starving cattle perish in their stalls,
Huge oxen stand inclos'd in wint'ry walls
Of snow conceal'd; whole herds are buried the
Of mighty stags, and scarce their horns appear.
The dextrous huntsman wounds not these after
With shafts or darts, or makes a distant war
With dogs, or pitches toils to stop their flight;
But close engages in unequal fight;
And while they strive in vain, to make their w
Through hills of snow, and pitifully bray;
Assaults with dint of sword, or pointed spears
And homeward, on his back, the burthen bears
The men to subterranean caves retire,
Secure from cold, and crowd the cheerful fire;
With trunks of elms and oaks the hearth they l
Nor tempt th' inclemency of heav'n abroad.
Their jovial nights in frolic and in play
They pass, to drive the tedious hours away.

309. Their food consists of dried fish, a flesh of bears, rein-deer, and other wild a Their drink is water, or train-oil as a when they can get it.

Obs.—Two inhabitants of Nova Zembla were to Copenhagen a few years ago; and they p want, till they met with some train oil, which the with the same relish as we would drink chore wine; and they danced in ecstacy, when they fo were to be sent back to their own country.

310. The next variety of the human are the Tartars, the Chinese, and the Ja

who inhabit all that vast space of Asia from the great Ocean to the Caspian Sea. They have broad foreheads and narrow chins, small sunk eyes, high cheek-bones, short and flat noses, large and separated teeth, short set statures, and olive complexions.

311. The Tartars have no settled habitation; but wander from place to place, and live with their horses and herds under tents covered with hides. The Chinese are the most numerous people in the world, inhabit the finest climate, and cultivate, with success, all the arts and sciences.

The Japanese inhabit certain large islands, and are not inferior to the Chinese in industry and ingenuity; but wisely allow little or no intercourse with meddling foreigners.

312. Another distinct family of the human race, are the black and swarthy inhabitants of India, and of the Islands of the Indian Ocean. They have European features, long black straight hair, and slender shapes. Their manners are effeminate; but their dresses and houses are very elegant.

Many millions of them, called Gentoos, never eat flesh, or any thing that has lived; but subsist chiefly on rice and fruits, and enjoy health, strength, and long life.

313. The peaceable habits of the Hindoos have, in all ages, rendered them a prey to foreign invaders. The Tartars have frequently invaded and plundered them.

Latterly, the European nations, particularly

the English, have established themsel
tlem; but though they have someti
mitted excesses, yet they are happily in
among the natives, the arts, philose
the religion of Europe.

814. The fourth variety of the huma
and the most remarkable of the whol
Negroes of Africa. Their black col
woolly heads, their flat noses, and thic
well known among us.

For many ages an infamous and pa
ing traffic was carried on in these pa
who were torn from their country t
the sugar-plantations of the West-Ind
happily, the slave-trade carried on
merchants has been abolished. The
now a prospect that other nations, pa
the Spanish and Portuguese, through
vention of Great Britain, will short
this nefarious trade.

815. These simple people inhabi
coasts and interior of Africa between t
and have been retained in a barbarou
the effects of the slave-trade; whic
their tribes and nations to make wa
other, for the purpose of stealing th
and selling them for slaves to Europea

AFRICANS.

HOTTENTOTS

316. The next distinct family of men, are the ative American Indians, spread in small tribes er the whole of that vast continent. They e of a dark copper-colour, have black hair, d small black eyes, high cheek-bones, and quently flat noses

As the Europeans advance, the natives re
and form the inhabitants of what are calle
the Back Settlements.

NATIVE AMERICANS.

317. The sixth variety of the European r
are the English, the French, the Germans,
lians, Spaniards, and other modern nati
These had their origin partly from the Sc
navians, (Swedes and Goths,) characterize
light hair and blue eyes; and from the C
distinguished by black eyes and black hair
The Swedes, English, Irish, Scotch, and
mans, are very fair; but the Italians, Fre
and Spaniards, are swarthy.

ENGLISH.

SPANISH.

118. The clear complexion of the Europeans best adapted to express the passions of the d and the health of the body; while the rgy of their understandings, and the vigour their corporeal frames, qualify them to carry the arts to perfection; and to raise man to t scale of eminence, to which he seems to e been fitted and destined by his Creator.

319. Such are the natures and the var
of men, as scattered over the face of the
Their numbers united are supposed to be
eight hundred millions: of whom, in E
every square mile contains 84, in Asia,
Africa, 6, and in America 3 individuals.

The whole number of human beings
renewed every 32 years, on the average, 2
lions must die and be born every year, i. e.
every hour, or 50 every minute.

Like leaves on trees, the race of man is found;
Now green in youth, now withering on the gro
Another race the following spring supplies,
They fall successive, and successive rise;
So generations in their course decay,
So flourish these, when those are past away.

320. As men have divided by chance
sign, into separate governments, they ha
sumed the names of Nations, Republics,
doms, or Empires; and the knowledge of
constitutes a leading feature of geogra
study.

The most populous nations are, the C
of 300 millions, the Hindoos of 10 millio
French of 30 millions, and the Russian
millions. The most extensive are the Ru
Chinese, Turkish, French and British em

321. From north to South, Europe is d
into Russia, Sweden, Denmark, Prussia, P
Saxony, Westphalia, France, Wurtem
Bavaria, Switzerland, Austria, Turkey,
Naples, Spain, Portugal, and Great Brita
Ireland.

Obs.—It will be highly proper that tutors

the map of the world, all these countries to the pupil, and render him expert in pointing to them himself. He ought also to be directed to write out the boundaries and latitude and longitude of each from the map. Nothing can be so ridiculous, as to compel children to commit verbal descriptions of the boundaries of countries to memory. The only guide is a good map; and *that* they ought to trace or copy, till they can answer any question that is put to them. No one need blush for ignorance of geography, after he has twice or thrice traced or copied maps. The scale of mountains in Goldsmith's "Illustrations of Popular Geography," should also be copied in maps, and the lines of comparative sizes deserve some consideration. The best exercises in mechanical and mathematical geography, however, are in the Geographical Copy-Books and the Royal School-Atlas.

322. The following is an enumeration of the names, capitals, and population of the countries of Europe:

Nations.	*Chief Cities.*	*Population.*
Sweden	Stockholm	3 millions.
Russia in Europe	Petersburgh	30 do.
Denmark	Copenhagen	3 do.
Prussia	Berlin	8 do.
Poland	Warsaw	6 do.
Batavia or Holland	Amsterdam	3 do.
Germanic States	Dresden	18 do.
Austria	Vienna	23 do.
Turkey in Europe	Constantinople	8 do.
France (proper)	Paris	30 do.
Switzerland	Berne	2 do.
Italy	Milan	4 do.
Etruria	Florence	2 do.
Pope's States	Rome	2 do.
Naples	Naples	6 do.
Portugal	Lisbon	4 do.
Spain	Madrid	11 do.
Great Brit. and Ireland	London	17 do.

323. Europe has three inland seas: the Mediterranean, the Baltic, and the White Sea; and

its shores are washed by the Atlantic, the of Biscay, the English Channel, the Nort Ocean, St. George's Channel, and the Ger Ocean.

324. The great European rivers are, the nube, the Rhine, the Elbe, the Weser, the M and the Oder, in Germany; the Volga and Nieper, in Russia; the Rhone, the Garo and the Seine, in France; the Thames, the vern, and the Humber, in England; the Cl in Scotland; and the Shannon, in Ireland.

Obs.—The rivers of South Britain are thus describe

——— ——— ——— *From his misty bed,*
Old father *Thames* advanc'd his rev'rend head:
Around his throne the sea-born brothers stood,
Who swell with tributary urns his flood.
First, the fam'd authors of his ancient name,
The winding *Isis* and the fruitful *Kame*:
The *Kennet* swift, for silver eels renown'd:
The *Loddon* slow, with verdant alders crown'd:
Cole, whose dark streams his flow'ry islands lave;
And chalky *Wey* that rolls a milky wave;
The blue transparent *Vandalis* appears:
The gulphy *Lee* his sedgy tresses rears;
And silent *Mole* that hides his diving flood;
And silent *Darent* stain'd with Danish blood.

325. The mountains of Europe are, the A of Switzerland; the Pyrenees, between Fra and Spain; the Dofrafields, in Norway; Welsh, in Wales; and Ben Nevis and Ben mond, in Scotland. It has also three volcan or burning mountains; viz. Etna, in Sicily; suvius, near Naples; and Hecla, in Iceland.

326. The British empire is composed of large islands, Great Britain and Ireland, several small ones, as the Isle of Man, the

st, the Hebrides, the Orkneys, Jersey and ey, and the Scilly-islands. Great Britain miles long, and 250 broad; and Ireland g, and 200 broad. Great Britain in- Scotland on the North, Wales north-west, gland on the south, east, and west.

England is subdivided into 40 counties, w:

Co.	Chief Towns.
berland	Newcastle
	Durham
land	Carlisle
reland	Appleby
re	York
re	Lancaster
	Chester
re	Shrewsbury
re	Derby
mmsh.	Nottingham
shire	Lincoln
	Oakham
rshire	Leicester
shire	Stafford
dshire	Hertford
ex	London
	Canterbury
	Guildford
	Chichester
re	Reading
	Warwick
shire	Worcester
dshire	Hereford
shire	Monmouth
rshire	Gloucester
shire	Oxford
mptns.	Northampton
ghams.	Aylesbury
dshire	Bedford
gdonsh.	Huntingdon
dgesh.	Cambridge
k	Norwich
k	Bury
	Chelmsford
shire	Winchester
shire	Salisbury
shire	Dorset
rsetshire	Bath
nshire	Exeter
wall	Launceston

Wales is divided into 12 counties, as

Co.	Chief Towns.
re	Flint
shire	Denbigh
nerys.	Montgomery
	Beaumaris
rvonsh.	Caernarvon
shire	Hanelech
	Radnor
nockshire	Brecknock
rganshire	Swansea
kshire	Pembrok
ganshire	Cardigan
rthensh.	Carmarthen

329. Scotland is divided into 33 cou follow:

Shires.	*Chief Towns.*	*Shires.*	*Ch*
Edinburgh	Edinburgh	Argyle	
Haddington	Dunbar	Perth	
Merse	Dunse	Kincardin	
Roxburgh	Jedburgh	Aberdeen	
Selkirk	Selkirk	Inverness	
Peebles	Peebles	Nairne and Cromartie	N
Lanerk	Glasgow	Fife	St.
Dumfries	Dumfries	Forfar	
Wigtown	Wigtown	Banff	
Kirkcudbright	Kirkcudbri.	Sutherland	Strath
Ayr	Ayr	Clackmannan	Cl
Dumbarton	Dumbarton	Kinross	
Bute and Caithness	Rothsay	Ross	
Renfrew	Renfrew	Elgin	
Stirling	Stirling	Orkney	
Linlithgow	Linlithgow		

330. Ireland is divided into four pr Ulster to the north, Leinster to the ea ster to the south, and Connaught to t and these are subdivided into 32 count

Counties.	*Chief Towns.*	*Counties.*	*Ch*
Dublin	Dublin	Antrim	Car
Louth	Drogheda	Londonderry	
Wicklow	Wicklow	Tyrone	
Wexford	Wexford	Fermanagh	I
Longford	Longford	Donegal	
East Meath	Trim	Leitrim	
Westmeath	Mullinger	Roscommon	R
King's County	Philipstown	Mayo	Carrick o
Queen's Co.	Maryborough	Sligo	
Kilkenny	Kilkenny	Galway	
Kildare	Naas and Athy	Clare	
Carlow	Carlow	Cork	
Down	Downpatrick	Kerry	
Armagh	Armagh	Limerick	
Monaghan	Monaghan	Tipperary	
Cavan	Cavan	Waterford	

Obs.—For the particulars of the British Empire, see oldsmith's British Geography.

331. ASIA includes countries the most po-ulous and fertile of any on the globe. It was, esides, the first peopled, the residence of our rst parents, the scene of scripture-history, and Canaan, Jesus Christ worked his miracles, nd promulgated the doctrines of revelation and future state.

332. Modern Asia contains Siberia, Tartary, hina, Birmania, Malacca, Hindostan, Thibet, ersia, Arabia, Syria, Turkey in Asia, besides e vast islands of Japan, Borneo, Sumatra, eylon, New Holland, the Philippines, Formo-, &c.

333. The internal seas of Asia are the Red ea, the Persian Gulph, the Caspian Sea, the apanese Sea, and the Yellow Sea. Its coasts re washed besides, by the Great Ocean, the ndian Ocean, the Chinese Sea, the Northern cean, the Bay of Bengal, and the Arabian Sea.

334. Its great rivers are the Ganges, the Eu-hrates, the Indus, the Amur, the Kian Ku, and e Hoan Ho; and the mountains where these se, are the Uralian, the Gauts, those of Cau-asus, Taurus, and Thibet.

335. British India, or countries governed by ngland in India, are those immense and fertile istricts watered by the Ganges called Bengal, f which Calcutta is the capital; nearly the hole of the coasts of the peninsula of India; nd the island of Ceylon.

"Where sacred Ganges pours along the plain,
And Indus rolls to swell the eastern main,

What awful scenes the curious mind delight;
What wonders burst upon the dazzled sight!
There giant-palms lift high their tufted heads;
The plantain wide his graceful foliage spreads
Wild in the woods the active monkey springs;
The chattering parrot claps her painted wings;
'Mid tall bamboos lies hid the deadly snake;
The tiger couches in the tangled brake;
The spotted axis bounds in fear away;
The leopard darts on his defenceless prey.
'Mid reedy pools and ancient forests rude,
Cool, peaceful haunts of awful solitude!
The huge rhinoceros rends the crashing boughs;
And stately elephants untroubled browse.
Two tyrant-seasons rule the wide domain,
Scorch with dry heat, or drench with floods of ra
Now feverish herds rush madding o'er the plains
And cool in shady streams their throbbing veins:
The birds drop lifeless from the silent spray,
And nature faints beneath the fiery day:
Then bursts the deluge on the sinking shore,
And teeming Plenty empties all her store.

336. China is at once the most ancient, most extensive, the most populous, and best regulated empire in the world. In it are more than 300 millions of people; and its laws and government have subsisted, with very little changes, for upwards of 3,000 years.

337. It is covered with canals, and every inch of its soil is cultivated. To secure it from invasion, it is separated from Tartary by a wall 1,500 miles long, and so thick, that five horsemen may every where ride abreast on it; yet the Tartars conquered China about 160 years ago, and still retain its government.

338. The chief cities of China are, Pekin, Nankin, and Canton, each of which contain

re inhabitants than London, and they are ra-
r more extensive. Canton is the only port
re foreigners are allowed to trade; and from
ce, the English bring teas and other Chinese
modities for the supply of Europe.

CHINESE.

139. The Birman empire, of which the capi-
are Ava and Pegu, separates China from
ia. Persia, celebrated in ancient history,
for many years been torn in pieces by civil
rs. Arabia is famous for the exploits of Ma-
met; and for the still wandering character of
inhabitants.

O'er Arabia's desert sands
The patient camel walks:
'Mid lonely caves and rocky lands
The fell hyena stalks.
On her cool and shady hills,
Coffee-shrubs and tam'rinds grow:
Headlong, fall the welcome rills
Down the fruitful dells below.
The fragrant myrrh and healing balm
Perfume the passing gale:

Thick hung with dates the spreading palm ...
O'er-tow'rs the peopled vale
Lucusts on, a living cloud,
Hover in the darken'd air;
Like a torrent dashing loud,
Bringing famine and despair;
And o'er the level waste
The stifling hot winds fly;
Down falls the swain with trembling haste;
The gasping cattle die.
Shepherd-people on the plain
Pitch their tents and wander free;
Wealthy cities they disdain,
Poor—yet blest with liberty.

340. The land of Canaan, now called Syr has been for four centuries in the hands of t Turks; and, like other parts of their empi has become almost a desert. Jerusalem, Be lehem, and the places recorded in the Old a New Testaments, are now supported chiefly pilgrims from Catholic countries, and there still chapels for their reception.

341. The following is a summary of the gr divisions of Asia: —

Nations.	*Chief Cities.*	*Popula*
Turkey	Aleppo	18 milli
Russia	Astrican	10 do.
China	Pekin and Nankin	300 do.
Japan	Jedo	30 do.
Birman Empire	Ava	17 do.
Siam	Siam	5 do.
Hindostan	Calcutta	60 do.
Persia	Ispahan	10 do.
Tartary	Samarcand	15 do.
Arabia	Mecca and Medina	10 do.

342. AFRICA is that quarter of the world wh lies, for the chief part, within the torrid zo

d is, consequently, burnt up by extreme
at, which engenders also ferocious wild beasts,
id every kind of noxious reptiles. It is there
re unhealthy; and in every respect unfavour-
ble to the civilization of man.

343. In ancient times, it was the site of Car-
hage—the rival of Rome, and for ages the mis
tress of the commerce of the world; and through
all history, Egypt has been famous as the Nur
sery of the Sciences, and the Emporium of
Commerce. At present, Carthage lies in ruins;
and Egypt is a prey to civil anarchy.

344. The northern coasts are inhabited by the
Moors, at whose head is the despotic Emperor
of Morocco. The piratical States of Algiers,
Tunis, and Tripoli, are also on these coasts. At
present, the Cape of Good Hope, the southern
promontory, and an English settlement, is the
only part of Africa adapted to the enjoyment of
man.

345. From the northern coasts to the Cape of
Good Hope, the whole of this immense continent
is inhabited by innumerable tribes or nations of
Blacks; many of them in a state of absolute
barbarism, and few possessing any considerable
degree of civilization.

346. The chief rivers of Africa are, the Nile
the Niger, and the Senegal. The mountains a
those of Atlas and the Moon. The islands are
Madagascar, the Cape Verd, and the delightf
Canaries, in one of which is the lofty Peak
Teneriffe.

347. The following is a survey of those of Africa which are perfectly formed:—

Nations.	*Chief Cities.*	*Popu*
Abyssinia	Gondar	2 mi
Egypt	Cairo	3
Morocco	Morocco	2
States of Barbary		3
Savage Tribes		50

348. Till the discovery of the powers o magnetic needle, navigators dared not to ture out of sight of land; but, about 200 after that discovery, Columbus, a Gen aware that the earth was round, conceived, if he sailed from Europe westward, he shou time arrive at the East Indies, without h to sail around Africa.

349. He sailed accordingly from Cadiz, i autumn of the year 1492, across the Atla and, on the morning of the 12th of Oct one of his anxious and mutinous crew land; not the East Indies, but Cat Island of the Bahamas, and part of a new world, then unknown to the other three quarters.

350. In fact, Columbus could not reach Indies in this direction; because the imm continent of America intervened from the N Pole almost to the South. America, and a islands, were found, at this time, to be pec by the race described in Art. 316; and a them were established the two extensive populous empires of Mexico and Peru.

351. Unhappily these empires, and

other parts of this new world, abounded in gold and silver; and, as the inhabitants knew not the use of gunpowder, and the rapacity of the Spaniards had no bounds, they destroyed nearly thirty millions of the natives, in a few years, to get possession of their riches.

352. The bloody successes of the Spaniards, however, led other European nations to embark in the same enterprize; and, within a century, the Portuguese established themselves in the Brazils, the English in Virginia, and the French in Canada.

Soon after, the fine islands called the West Indies, were successively colonized by different powers, for the sake of their produce in sugar, rum, and other tropical luxuries.

353. At length, in 1776, the populous English colonies in North America declared themselves independent; and, after a bloody contest of seven years, they were recognized as a new empire, under the title of the United States of America, then thirteen, but now *nineteen* in number.

354. These States, under a free, prudent, and wise government, form now the happiest and most flourishing countries in the world; and are the refuge of people driven from the various nations of Europe, by ruinous wars and political revolutions. Their head is called a President; he is chosen for three years, and governs according to laws made by two houses of legislature.

355. The chief towns are Washington, Phila-

delphia, New York, Boston, Baltimore, an Charlestown. The chief rivers, and the fine in the world, are the Delaware, the Chesapea the Hudson, the Mississippi, the Ohio, and t Missouri.

356. North and westward of the United State lie Upper and Lower Canada, two immense di tricts still subject to the British empire; t capitals of which are Quebec and Montre both situated on the immense river St. Laurenc

Obs.—This great river joins five lakes of fresh wat the largest in the world; and between two of them a the grand falls of Niagara.

357. Southward of the United States, lies t Gulf of Mexico; in which are situated, t islands called the West Indies—as Cuba, St. D mingo, Jamaica, Porto Rico, Barbadoes, Mar nico, Guadaloupe, Tobago, St. Kitts, &c.

358. By turning to the map, it will be seen th North America is joined to South America by long slip of land called Mexico, and the Isthm of Darien, occupied or governed by the Sp niards, as well as the greater part of Sou America itself, ever since the discoveries of C lumbus.

359. In this immense continent, the thr Spanish viceroys of Mexico, Peru, and Buen Ayres, have for three centuries governed cou tries each more extensive than all Europe, a abounding in gold and silver, and various v luable productions.

360. South America is watered by the larg rivers in the world, as the Amazons, La Pla

and Oronooko. In the Andes, it possesses the highest chain of mountains, some of them four miles high; and among them are the most productive gold and silver mines in the world.

361. South of Peru is Chili; and south of Chili the inhospitable and frozen regions of Patagonia; among whose scanty inhabitants are some tribes of gigantic stature, from 6½ to 7 feet high. Terra del Fuego, or the Land of Fogs, is the most southerly region of America, and Cape Horn is its extreme point.

362. The following is an enumeration of the organized districts and countries of America:—

NORTH AMERICA.

Nations.	*Chief Cities.*	*Population.*
United States	Washington	10 millions.
Spanish Dominions	Salvador	6 do.
British Possessions	Quebec	1 do.
Native Tribes		2 do.

SOUTH AMERICA.

Spanish Dominions	Lima	9 do.
Portuguese Dominions	Rio Janeiro	2 do.
Native Tribes		4 do.
South Sea Islands		2 do.

363. The Great or Pacific Ocean is filled with numerous clusters of islands, called the Society Islands, the Friendly Islands, the Sandwich Islands, Phillips's Island, &c. all discovered by the English within the last fifty years. The inhabitants live in a natural savage state; and the anecdotes of their simple manners form the charm of the voyages of Wallis, Cook, and others.

364. MAPS are exact portraits of the surface of the earth, viewed as from an eminence, or

laid down according to a *scale*, in part retains its exact proportion.

The top of a map is the *north*, the *south*, the right-hand is the *e* left-hand the *west*: when these poi cated by a compass engraved on th north is indicated by a *fleur-de-lis*.

Obs. 1.—It would be well to convey t principle of maps to children, by showing of the place where they live, or a map o or district, laying it in the position of the

2. Young persons should be taught the means of the problems in Goldsmith's Roy

365. The figures running from no or south to north, at the side of a m the *latitude* or distance in degrees from the equator. The lines acr guides to the eye, to connect the fig side, and are called the *parallels*. When the figures increase upward, latitude; if downward, it is south l

366. An imaginary line, which every person or place on the eart north pole to the south pole, is cal ridian; and the distance between dians, measured at the equator, i *longitude*.

The figures at the bottom and to indicate such distances between me the lines which join them are calle The longitude is *east* when the diste from left to right; or *west*, when it ir right to left.

Obs.—See the annexed map of the whole amine, study, and copy it.

7. A globe is an exact portrait of the earth
navens. For the facility of working pro-
s, it is provided with a universal *brass me-*
n; with a universal *wooden horizon*; with
our circle to reduce its motion into time·
a compass to set it due north and south;
with *a quadrant* to measure distances and
ides.

8. As the earth, which is 360 degrees round,
any place to the Sun in every 24 hours, of
e, 15 degrees turn to and from the Sun in
hour, and one degree in every four mi-
.

e hour of the day, therefore, at different
s, depends on their difference in longitude,
ulated in the above proportion; all places
e east moving under the Sun, or having their
sooner than those to the west, because the
turns from west to east.

.—Bristol is nearly Longitude two degrees west
ndon; it therefore passes under the Sun eight mi-
later than London arrives at the Sun; and of course,
it is twelve o'clock at London, it wants eight mi-
of twelve in Bristol; or when it is twelve in Bris-
is eight minutes after twelve in London. In work-
gh problems, it is simply necessary to bear in mind,
e whole earth of 360 degrees turns round in twen-
ir hours; and, of course, that the clocks every
vary in proportion to the distances of their meri-
, or the difference of their longitudes.

XV. *Of Morals and Religion.*

9. Man is not well adapted to a social state,
s his conduct be restrained by a respect
thers beyond what is imposed by Laws;

that is, except he be actuated by an habi
sense of what is *right*, and by feelings of
morse for having done what is *wrong*.

370. In due time he will find, that his h
ness consists in restraining his own passions
sensual propensities; in doing good to oth
and in rendering *his existence useful*, by crea
a reliance in others upon his labour, skill,
kindness.

371. The perception which every man
of what is right and wrong, is called *the M
Sense*; and it appears to arise from a consci
ness of doing, or not doing to others what
would have them do to us, were our situat
reversed. *Doing to others*, therefore, as
would that others should do to us, is the gol
rule of social virtue.

Obs.—Another rule as universal, and not less im
ant to the cause of virtue, is *never to do an act which
would be ashamed to have known*.

372. The practice of virtue implies restr
on our own wishes, and on our respecting
rights and happiness of others; restraint is
result of habit, and habit is produced by e
cation. Hence the necessity of education,
restraining vicious propensities, and for prod
ing virtuous *habits*, on which depend all
happiness and prosperity.

Obs. The golden rule of *virtue* is also the golden
of *manners*; true politeness consisting in deference
others, and conceding our own wants and wishes to
pleasure and enjoyment of others.

373. There are no general rules so uneq
as those, that virtue ought always to be p

tised, because it is productive of happiness; and that future misery is an inevitable consequence of vicious habits.

374. Such were the results of men's own experience in the pagan world; but at length it pleased Almighty God to send his only Son Jesus Christ among his chosen people, the Jews, to recall them, and all mankind, from their idolatries; and to convey to them a just knowledge of ONE GOD, the maker of all things, and of the immortality of the soul of man after this life of probation.

375. The history of this divine Personage is met with in the writings of the four Evangelists; in which, his precious doctrines are recorded for the instruction of mankind.

As everlasting foundations of virtue, these writings, those of the Apostles, and the whole Bible, should be consulted by young and old, for that wisdom which surpasses finite inquiry, and the delusive knowledge of man.

Obs.—The best, and perhaps the only, method of studying the New Testament, is by means of Barrow's 300 Questions.

376. By the information of the holy scriptures, and the inferences of our reason, deduced from the perfection of his wonderful works, we learn that there is ONE GOD; that he is a Supreme Being; First Cause; the Creator of the universe; Omnipotent, or all-powerful; Omniscient, or all-wise; Infinite, or present every where; and Eternal, or without beginning and without end.

In the Vast and the Minute, we see
The unambiguous footsteps of the God
Who gives its lustre to an insect's wing,
And wheels his throne upon the rolling worlds.

977. We learn, and we perceive, that God is always present with us; that all our thoughts and actions are known to him; and that we are accountable for them in a future state of immortality, which will follow this transient and ephemeral existence. Hence, we have a far more powerful stimulus to virtuous conduct, than mere temporal happiness.

I read his awful name, emblazon'd high
With golden letters on th' illumin'd sky;
Nor less, the mystic characters I see
Wrought in each flower, inscribed on ev'ry tree;
In ev'ry leaf that trembles on the breeze,
I hear the voice of God among the trees.

978. Some virtues, from their great importance, are called Cardinal Virtues; these are Piety, Charity, Temperance, Justice, Prudence, and Fortitude.

a. *Sincerity* is that desirable virtue which deals plainly and honestly, without disguise, falsehood, or hypocrisy.

b. *Charity* is that amiable virtue which leads us to relieve the distresses, tolerate the infirmities, pity the sufferings, and ameliorate the condition of all sensitive beings; and it opposes itself to persecution, cruelty, and oppression, and all barbarous practices towards men, or insects.

e. *Temperance* sets bounds to our desires, ambition, and passions; opposes our self-love, vanity, and sensual gratifications; and leads to contentment, health, and long life.

d. *Justice* is that virtue which leads us to do to men and animals that which we would they should do to us, were we in their situation and they in ours; and it is the opposite of tyranny, and of practices towards others, founded on our own supposed impunity.

Obs.—Tenderness to animals, and to all who cannot help themselves, or resist our power, is the primary duty of all men.

e. *Prudence* is that useful virtue which results from experience, of what is fit or unfit for our condition; and being possessed by the aged and by parents, their precepts ought to have full weight on the minds of children.

f. *Fortitude* is that necessary virtue, which enables us to bear with the adversities and accidents of social life; and which keeps us steady in the practice of virtue.

379. In early ages, the Christian world became divided into two great bodies, called the Greek church and the Romish church.

The *Greek* church was, and is still, established in Russia, Turkey, Asia, and Greece.

The *Romish* church spread its influence over the west of Europe into Germany, France, Spain, Sweden, Britain, &c.

380. Soon after the invention of printing, the abuses and palpable errors of the Romish church

led to the efforts of Luther, Calvin, Cranm and others.

A reformed religion was, in consequence, established in Great Britain, Germany, Swede Holland, and some other countries, called *Protestant*, from the early reformers protesti against the proceedings of a Romish council.

381. The Protestants have subdivided the selves into

Lutherans, or followers of Luther.

Calvinists, or those who prefer the doctrin of Calvin.

Arminians, who follow those of Arminius.

Socinians, those of Socinus.

Anglican, who prefer the national church England, and its rites and liturgy.

Presbyterians, who deny the authority bishops.

Independents, who adhere to the princi that every church, or society of Christians, h a right to govern itself without the interferen of another.

Baptists, who disapprove of infant baptis

Quakers, who have no external religious c remonies, or sacraments.

Unitarians, who deny the doctrine of t Trinity.

Swedenborgians, who believe in the divi mission of Emanuel Swedenborg.

And *Methodists*, who use the church-liturg but preach extemporaneously.

382. The Jews still exist as a distinct peo

in all parts of the world, over which they are dispersed, according to ancient prophecy, preserving every where their religion and original language.

383. In Turkey, and in most parts of Asia and Africa, the religion of Mahomet, an Arabian impostor of the 7th century, still prevails; and descendants of Mahomet still occupy several Asiatic and African thrones, as sultans, emperors, &c.

384. In China, the national religion is founded on the pure belief of ONE God; and on the moral writings of Confucius, a Chinese philosopher.

In India, many superstitions and much idolatry prevail; but the effect tends to maintain subordination and industry; while it teaches peace among men, and charity even to animals and insects.

385. In other nations, Christianity is silently working its way among the people; and civilization and Christianity appear happily to go hand-in-hand in Africa, in America, and among the South-Sea islanders, the majority of whom entertain the grossest superstitions and idolatries.

Obs.—For all necessary knowledge on the subject of theology, and as a general note-book to the Bible, and to all religious inquiries, consult Dr. Robinson's Theological Dictionary.

XVI. *Grammar.*

306. The power of communicating ideas by speech is peculiar to man; but it is a power on which depends his improvement in all the arts; because the gradation and accumulation of improvements depend on co-operation and continuation.

Neither could exist, if the power were not attained of describing improvements to the living, and of transmitting them to posterity.

307. The language of savage nations is, however, very limited: they are able to call a few hundred things by their names; to express some qualities; and name a few modes of action; but they express more by gesture than by sound: few of them can count above ten; and when desired to express a higher number, they shew the hair of their heads.

308. The most ancient languages consisted of two or three hundred monosyllables, expressing general ideas:—as air, sea, tree, man, God, house, good, bad, &c.: and all other words, by a systematic combination, were formed out of these: such were the Welsh, Chinese, and some other languages.

309. The first sounds used by savages, were mere cries of pleasure and pain; as *Oh! Ah!* and such other words, called INTERJECTIONS.

They next named visible objects; as *river, tree, grass,* &c.; thereby introducing a new class of words, called NOUNS.

They then derived from nouns, a class of words to express corresponding actions; as *walk, talk, eat, drink,* &c., called VERBS.

390. The next class of words were intended to describe the qualities of *nouns* and *verbs;* as *tall, swift, short, fast,* &c., called *ad*-NOUNS and *ad*-VERBS.

Words, to describe the position of nouns in regard to each other; as *to, from, above, below,* &c., were also among those necessary to a language, and these were called *pre*-POSITIONS.

391. The seventh class was a mere refinement of speech, and consisted of words used in place of nouns; as *he, she, it, they,* &c., called *pro*-NOUNS.

The eighth class was intended to give precision to the noun; as *a* man, or *the* man, and were, therefore, called ARTICLES.

And the ninth class consisted solely of words intended to *join* others together in a discourse; as *and, because, but, yet,* &c.; and are called CONJUNC-*tions.*

392. Such were the origin and progress of speech; and such, without variation, is the general composition of language. The English, and most other languages, contain *nine* kinds of words, or parts of speech, named as above; and the science of grammar merely supplies general rules for their arrangement and government.

393. The classification of *all* words into *nine kinds,* enables grammarians to simplify the rules which direct the construction of language.

stead of a rule for every word, a fe
all that become necessary to regulat
sand words.

Obs.—For the details of grammar, I r
student to my own *Practical Grammar*; or
modern grammar which is not too long
My own *Grammar* is in its sixth edition;
most flatteringly received by many an
master.

394. All names of things, are cal
substantives; all qualities of things
ad-nouns, or *adjectives*.

All actions are expressed by *verb*

All words, which modify actions
are called *ad-verbs*.

All words, which describe the po
sons and things, are called *pre-positi*

All words, which are used instea
or for nouns, are called *pro-nouns*.

All words, which are used to joi
or parts of sentences, are called *con*

The words *a* or *an*, and *the*, ar
ticles.

The exclamatory words, which e
nestness or surprise, are called *inter*

395. The first written signs of
hieroglyphics, or characters, which
the object named by the charact
course, there were nearly as many
ideas. The characters now used f
of the Zodiac and the Planets are
this kind of character; and so is a *cir*
when used to signify eternity.

396. The invention of letters, b

which all sounds could be represented, is ascribed to some wise man in the reign of Cadmus, king of Thebes. This simple contrivance facilitated the propagation and preservation of knowledge, by enabling us to express a million of words, if we desired it, by the various combination of only twenty-four or five characters.

Obs. 1.—In the GREEK LANGUAGE there are twenty-four letters; of which seven are vowels, and seventeen consonants:—

Α α	Alpha	Ἄλφα	a
Β β ϐ	Beta	Βῆτα	b
Γ γ ϝ	Gamma	Γάμμα	g
Δ δ	Delta	Δέλτα	d
Ε ε	Epsilon	Ἒ ψιλόν	e short
Ζ ζ	Zeta	Ζῆτα	z
Η η	Eta	Ἦτα	e long
Θ ϑ θ	Theta	Θῆτα	th
Ι ι	Iota	Ἰῶτα	i
Κ κ	Kappa	Κάππα	k c
Λ λ	Lamda	Λάμδα	l
Μ μ	Mu	Μῦ	m
Ν ν	Nu	Νῦ	n
Ξ ξ	Xi	Ξῖ	x
Ο ο	Omicron	Ὂ μικρόν	o short
Π π ϖ	Pi	Πῖ	p
Ρ ῥ ϱ	Rho	Ῥῶ	r
Σ σ ς	Sigma	Σίγμα	s
Τ τ	Tau	Ταῦ	t
Υ υ	Upsilon	Υ̓͂ ψιλόν	u
Φ φ	Phi	Φῖ	ph
Χ χ	Chi	Χῖ	ch
Ψ ψ	Psi	Ψῖ	ps
Ω ω	Omega	Ὦ μέγα	o long

The vowels are a, e, u, i, o, y, w.

2.—The following is the ancient HEBREW ALPHABET of twenty-two letters, of which five are vowels, and the rest are consonants

Name.	Form.	English So
Aleph	א	a broad, as in
Beth	ב	b
Gimel	ג	g hard, as in g
Daleth	ד	d
He	ה	e, as in *where*
Vau	ו	u, as *oo*, w before
Zain	ז	z
Heth or Cheth	ח	h hard aspirate
Teth	ט	th
Yod	י	i like *ee*.
Caph	כ	k or c hard, as
Lamed	ל	l
Mem	מ	m
Nun	נ	n
Samech	ס	sh
Oin	ע	o long, as *who*
Pe	פ	p
Tsadi	צ	ts soft, as z in
Koph	ק	q or qu.
Resch	ר	r
Shin or Sin	ש	s
Tau	ת	t

The vowels are א ה ו י

807. The English language consists 40,000 words; and is derived from t Gothic, and Latin; successively inv by the Welsh, Romans, Saxons, Danes, mans; and by the terms used in the derived from the Greek, French, It German languages.

808. Grammar, in a limited sense, which teaches the construction of ph

ntences; but, in an extended sense it em-
races the whole science of language.

The study of language is properly divided into
e seven following branches:—Orthoëpy, Or-
ography, Accidence, Syntax, Prosody, Rheto-
ic and Composition.

399. *Orthoëpy* consists of rules for pronoun-
ing letters and syllables according to the estab-
lished usage.

Orthography is the art of writing words with
he proper and necessary letters.

The *Accidence* treats of the modification of
he different kinds of words, called parts of
peech.

Syntax furnishes the rules for the proper con-
truction and just disposition of words in a sen-
tence.

400. *Prosody* teaches the right accentuation
of syllables; and the different measures of
erses.

Rhetoric enables us to affect or convince those
whom we address in speaking or in writing, by
using suitable figures of speech.

Composition teaches us to arrange our thoughts
with precision and elegance; and is, conse-
quently, the object and end of the study of lan-
guage.

401. The nine kinds of words, or *nine parts
of speech*, compose most languages; and there
are in the English language about 20,500 nouns,
60 pronouns, 9,200 adnouns, or adjectives,
5,000 verbs, 2,000 adverbs, 69 prepositions, 19

conjunctions, 68 interjections, and 2 articles;—in all above forty thousand words.

402. After we have acquired a stock of words by reading and copying the best authors, and mixing in good company, we should learn to arrange and combine them in a sentence with elegance; and in such manner, as exactly to express the sense we intend to convey, and no other than that sense;—a power of writing which is called *perspicuity*.

403. The great rule for the attainment of the art of composition, is to conceive, ourselves, that sentiment which we purpose to convey to others, by previously reflecting upon it; as it is impossible to express clearly to others what we do not well understand ourselves.

404. We should never desire to express too many ideas in one sentence; but dispatch them one after another in their proper order; and confine ourselves to simple and short sentences till we have acquired facility in the management of them.

Obs.—The best exercise in writing and speaking is to read a short story, and then write or speak it, in our own phraseology. Such an exercise continued every day for two years, one day writing, and the other speaking, would teach the arts of spelling, writing, and speaking, at the same instant.

405. We should avoid all quaint phrases, cant words, vulgar proverbs, and foreign idioms; and make our choice from the phraseology of the Old or New Testaments, the book of Common Prayer, or the works of Addison or Shake-

veare; and avoid the latinized phraseology of Johnson, and the Gallic phraseology of some other modern writers.

Obs.—Happily, the translation of the Bible and the book of Common Prayer have served to preserve our language; or it would have been lost amidst the barbarous affectations of Johnson and his followers. We have nowhere such variety of beautiful and affecting language as in the Old and New Testaments; and these, with the book of Common Prayer, and the works of our immortal Shakespeare, will, I hope, preserve our language from the corruptions and innovations daily making in it, by those who prefer sound to sense.

406. To speak or write our ideas in an able and persuasive manner, we ought to possess ourselves of various knowledge; to read the best books on all subjects; to suffer no hour to pass, without making some improvement; and think, talk, and write ourselves on subjects, on which we have perused the opinions of others.

407. We should commit to memory the terms and leading facts of the various Arts and Sciences; and frequently reduce to writing, striking facts or important sentiments which we meet with in reading. We should compare one author with another on the same subject; and frequently converse with others, on any points in which authors do not satisfy our curiosity.

Obs.—Dr. Lavizo's Elements of Composition is a library for young persons; and the study of it should follow that of every grammar. Adair's Questions render it practical for Schools.

XVII. *Logic.*

400. Logic is that important and useful which teaches the art of *correct thinking*. logicians give five general rules, by wh assist our views in thinking, writing, and ing on all subjects.

As these rules are of great and constant use, copied them from my own English Grammar:—

a. Conceive of things *clearly and distinctly* in their own natures.

Obs.—That is, we should acquire a clear and conception of things as they are in their own and not be content with obscure and confused when clearer are to be attained.

b. Conceive of things *completely*, in all parts.

Obs.—There is a metaphysical, or ideal whole, thematical, or integral whole, and a physical, or whole.

c. Conceive of things *comprehensively*, their properties and relations.

Obs.—That is, we must consider them in all modes, attributes, properties, and relations; in order attain a comprehensive view of their essential m attributes, and of their various occasional pro accidental modes, and relations.

d. Conceive of things *extensively*, in all kinds.

Obs.—That is, we must search out the various or special natures, which are contained under the as a genus or general nature: as, if we would kn nature of an animal perfectly, we must take cogn of beasts, birds, fishes, and insects, as well as me which are contained under the general nature and of animal.

:eive of things *in order*, or in a proper

at is, we should rank and place our ideas in
ethod and just order. We must not conceive
a confused heap: but dispose our ideas in
d, which may be easy and useful for the un-
: and memory.

IETHOD is analytical or synthetical.
al method resolves the compound into
iples, and the whole into its parts.
al, begins with the parts and leads to
or it puts together the principles and
ompound.

Arguments are either metaphysical,
political, moral, mechanical, or theo-
:cording to the science or subject from
:y are drawn. The following deserve

Argumentum ad judicium, is an appeal to the
nse of mankind.
Argumentum ad fidem, is an appeal to the faith.
Argumentum ad hominem, is an appeal to the
r professed principles of the adversary.
Argumentum ad populum, is an appeal to the

Argumentum ex concessis, is when something is
means of some proposition previously con-

Argumentum ad passiones, is an appeal to the

Argumentum a fortiori, proves the conclusion,
: a less probable proposition on which the
depends.
Argumentum ad ignorantiam, is founded upon
principles, which the opponent has not skill

i. Argumentum ad verecundium, is drawn from authority we are ashamed to dispute.

k. A *direct argument* is that which immediately proves the proposition in question.

l. An *indirect* argument proves the conclusion; by proving or disproving some proposition upon which the conclusion depends.

411. *Certainty* or *Truth* is of several kinds: there is a *mathematical certainty*, which admits of demonstration; a *moral certainty*, which is derived from testimony; a *physical certainty*, derived from the evidence of the senses and the course of nature; and a *theological certainty*, founded on the doctrines of the Scriptures.

412. *Evidence* is of different kinds; as the *evidence of sense*, founded on the perceptions of our senses.

The evidence of intuition, founded on self-evident axioms; as that the whole is greater than a part, or, every effect is produced by some cause.

The evidence of reason, founded on clear and indubitable deductions from well-founded premises and doctrines.

And *the evidence of faith*, deduced from the testimony of others.

413. *Demonstrations* are a succession of connected Propositions, beginning with self-evident truths and advancing to remoter ones.

A Demonstration à priori, is when the effect is proved by referring to the cause.

A Demonstration à posteriori, is when the cause is inferred from the effects.

Obs. — *Corollaries* are self-evident inferences from established propositions.

414. *Sophistry* is false reasoning, founded on false premises, or on ambiguity of terms.

Obs.—As most of the evils which exist in society grow out of sophistry, no art is more important than that which enables us to detect or expose it. The crimes of courts and wicked ministers usually escape punishment, from the effect of sophistry; and there would be few or no wars, if sophistry did not triumph in the statements of the parties.

A Sophism of Composition, is when we infer that of any thing in an aggregate or compounded sense, which is only true in a divided sense.

A Sophism of division, is when we infer any thing in a divided sense, which is only true in a compounded sense.

A Sophism of equivocation, is when we use words of an ambiguous or double sense, and draw inferences in one sense, of which the proposition is capable only in the other.

415. *A petitio principii*, or begging the question, is the supposition of what is not granted, or a supposed proof, by stating the question in other words.

The reductio ad absurdum, is when the truth of a proposition is proved by shewing the absurdity of a contrary supposition.

416. *Induction* consists in distributing a general idea into its species, and ascribing to the whole the property found in the species.

A false induction is when general deductions are made from too limited a number of experiments or facts.

The fallacia accidentis, is when we draw in-

...e in regard to the nature of a thing, from
...stances only temporary or accidental...
... in a mistake of the ...

Ignorantia elenchi, ...
...ion, or when one thing is proved ...
...other.

...nalogy is an argument in which, from cor-
...onding causes, are deduced corresponding
...ets.

...es.—The sources of errors are, (1.) The want of att-
...ce in investigation. (2.) Judging of things by their
...ernal appearances only. (3.) Not separating the
...nd and bad qualities that pervade the same thing, ha-
...rming a hasty judgment. (4.) Comparing things wi-
...ur own situation in life; or as they happen to affect u
(5.) Associating an idea with something disagreeable,
...he contrary. (6.) Prejudices formed in our infan-
(7.) Giving credit to the assertions or misrepresentati-
of others, without inquiring into their motives, an-
news-writers and reviewers; and (8.) Submitting to
force and influence of custom and fashion.

417. *A Syllogism* is a sentence made u...
three propositions, so disposed, as that the l...
necessarily inferred from those that prece...

Every *Syllogism* contains two premises...
conclusion; or a major and minor prop...
and a consequence.

Example of a Syllogism:

Major. - - Our Creator ought to be worsh...
Minor. - - God is our Creator.
Consequence. *Therefore* God ought to be w...

418. An *Argument* is a series of syl...
and, although arguments do not re...
syllogistic form in ordinary discour...
arguments may be reduced to syllog...
errors or sophisms may thus be dete...

Formerly, Logic, or the art of reasoning, must the sole business of a university edu- but it is now in some degree superseded, practice of reasoning in the study of ma- ics, by the various branches of philoso- ed by the perusal of the classic authors.

The great master of philosophy, ARISTOTLE, di- science into TWENTY formed of SYLLOGISMS, yllogisms were composed of PROPOSITIONS, which ions were formed of TERMS; which Terms were e Signs of our IDEAS of THINGS. He then con- ll Things with reference to their TEN CATEGO- *Predicaments*; as *Substance*, *Quality*, *Quantity*, *Action*, *Passiveness*, *When*, *Where*, *Position*, t.

XVIII. *Rhetoric.*

Rhetoric teaches us to affect the pas- y suitable illustrations and imagery; and nge our arguments to the best advantage, o make the deepest impression on the and judgment of those whom we address. The following are the chief figures of

imile or Comparison, is that figure by we compare one thing with another for e of illustration

letaphor, is a comparison expressed with- signs of comparison; as, when we say of ter, that *he is the pillar of the state*, we in metaphor; and when we say, that *the Twelfth was the lion of the north*, we metaphorically.

llegory, is a continuation of several me- , so connected as to form a kind of pa-

rable or fable; as, in describing the Israel under the image of a vine.

d. Irony, is a figure in which we thing, and mean the contrary, in ord effect to our meaning; as, in describi rious cheat, we say, ironically, *A migh man, truly!*

e. Hyperbole, gives us the highest i object, and magnifies it beyond its n mentions; as, *Achilles was swifter tha*

f. Antithesis, is the contrast or opp two objects in a sentence; as, *If y make a man rich, study not so much t his stores, as to diminish his desires.*

g. Climax, or gradation, is a figure we rise from one circumstance to an our idea is raised to the highest.

h. Personification, is a figure by attributes life and the use of reason to objects and irrational creatures.

i. Apostrophe, is a figure by which w absent persons, or inanimate objects personify.

k. Interrogation, is a figure which, a question, gives ardour and energy t course.

l. Exclamation, is a figure that some strong emotion of the mind, and ally followed by a note of admiration

499 Rhetorical disposition or arran the *placing* of the *arguments*, or the discourse, oration, or composition, in suitable and impressive order.

The parts of a discourse are sometimes five, and sometimes six; viz. the Exordium, the Narration, the Proposition, the Confirmation, the Refutation, and the Peroration.

a. In the *Exordium*, or beginning of a discourse, the writer or speaker gives some intimation of his subject, and solicits favour and attention.

b. The *Narration* is a brief recital of the facts connected with the case from the beginning to the end.

c. In the *Proposition*, is given the true state of the question; specifying the points maintained, and those in which the writer or speaker differs from the adversary.

d. The *Confirmation* assembles all the proofs and arguments which can be adduced.

e. In the *Refutation*, the writer or speaker answers the arguments and objections of his opponent.

f. In the *Peroration*, he sums up the strong and principal arguments, and endeavours to excite the passions in his favour.

423. A distinct and audible *delivery* is essential to a good orator.

The *first* rule is, to open the mouth sufficiently, and not to mumble or mutter the words.

The *second* is, to pronounce distinctly every letter and syllable without hurry.

And the *third* is, to fill the room with the voice, so that the most distant part of the auditory may hear.

424. In regard to *gesture*, th
tural is the best, provided it is n
offensive.

The head should be held up,
should look those whom he is a
face.

His action should be easy, m
pace with his voice and the m
course.

He should also avoid contort
grimaces; ease in delivery b
grace of oratory.

XIX. *Of Vegetable*.

425. Every substance known
ble into three kingdoms, the Mi
and Animal. Linnæus thus dis
kingdoms: "Stones *grow*; -
and *live*;—and animals grow, l

Obs.—For the *Mineral* kingdom se

426. The existence of all veg
regarded as mechanical, or as s
an animal when asleep, during
functions proceed without cons
mechanism of plants is, howeve
ful; and bespeaks the contrivan
and all-powerful Creator.

427. A seed, which is thrown
by the husbandman, is similar in
to the egg of an animal. The e
it, by means as inexplicable to
which the sitting of a hen on
it into a chicken.

n a few days, the two ends of the seed
id from one of them issues a green
d from the other a number of fibrous

ver was the position of the seed, the
rout struggles through the soil *upward*
ir; and the fibrous shoots strike *down-*
› the ground; and there imbibe, trans-
ump up, the moisture, as nourishment
ant.
Soth'ng is more wonderful than the
nature for the preservation of seeds;
contrivances by which they are distri-

seeds are provided with downy wings,
ndelion; others are swallowed by ani-
l voided again in distant places; and
own about by the winds, and preserved
coverings, till excited into germination,
eat of the sun's rays in the following

Botanists have divided all plants into
s, and 121 *orders*; and they have dis-
2,000 *genera*, 30,000 *species*, and va-
the species without number.
has its peculiar habitation; and each
he nutriment derived from the same
› differently, that, by an unknown
it produces all the degrees of flavour,
oison, and nutriment, which we find in
lants.

e, each plant, from all its branching roots,
e globe small hollow fibres shoots;

Which drink with thirsty mouths the vital ju
And to the limbs and leaves their food diffus
Peculiar pores peculiar juice receive;
To this deny, to that, admittance give. 31.

Obs. 1.—Of the different distinctions of *leaves* cording to their position and form, above one are enumerated. In all of them, one of the offi subtilize and give more spirit to the abundance rishing sap, and to convey it to the little buds are two orders of veins and nerves in leaves, on ing to each surface; and it has been generally that the under side of the leaf, has the ram larger, and are capable of admitting a liquid through them which those of the upper surface The under side of the leaf is supposed to be inte receiving, preparing, and conveying the moi bibed from the rising vapours of the earth, by wh and plants are greatly nourished; so that one p use of leaves is to perform, in some measure, office for the support of vegetable life, as the animals do for the subsistence of animal life.

2.—Another of the great functions for which t of trees and plants are designed, is that of th stalks nourishing and preparing the buds of th shoots, which are always formed at the base of th stalks. Leaves, moreover, are designed to al buds for the future shoots from the sun; whic otherwise exhale and dry up all their moisture. dently passes in at the leaves and goes through t plant, and out again at the roots. If the leaves air, the whole plant will die. This has been pr experiments with the air-pump. And plants draw through their leaves some part of their nou from the air, but the leaves also perform the n work of altering the water received in at the ro the nature and juices of the plant; and hence that the life of the plant depends so immediatel leaves.

431. Every plant consists of a root, t trunk or stem, of leaves, of props or ar

scence; and of the parts of fructifi-

regard to their bulk, plants are di-
trees, *shrubs*, *under-shrubs*, and *herbs*,
die in the winter.
ng to their respective durations, they
l, lasting one year, and reproduced
seed; or *biennial*, when they are pro-
me year, and flower the next; *peren-*
i they last many years, as trees.
ants, in regard to the *roots*, are *bul-*
i onions or tulips; *tuberose*, as in tur-
tatoes; and *fibrous*, as in grasses.
e *deciduous*, when their leaves fall in
nd *ever-green*, when they are con-
ewed, as in most resinous trees.
e said to *sleep*, when they change the
e of their leaves or flowers at night.
e *indigenous* or native; and *exotic*

e parts of *fructification* consist of the
up, which is the outer green covering

lls are the delicate leaves or petals
er generally coloured, and are the
i constitute the beauty of the flower.
ary, or nectarium, is the part within
which secretes the honey.
e calyx and corolla are fine expan-
: outer and inner bark or rind of the
their evident purpose is, to protect
cate extensions of the pith and wood,
r within the corolla, and are called

the *pistil* and the *stamen*, by the pec ganization of which the seed is produc

436. The *pistil* is provided at its hea gummy matter, and the *stamen* with a called *pollen*; and when the dust fall head of the pistil, it is there absorbed ried down the *style* of the pistil to the or seed-vessel in the centre of the flower the *seed* is, in consequence, produced *pericarp*, afterwards called *fruit*.

437. Fruits, which afford us so ma ries, are, in fact, nothing more than th ing, or the natural means for protec seed of plants, and called, by botanis *carps*.

Some pericarps are *pulpy*, as thos ples, pears, nectarines, &c.; some h as nuts; and some *scaly*, as the cone trees.

Your contemplation further yet pursue;
The wondrous world of vegetables view!
See various trees their various fruits produce,
Some for delightful taste, and some for use.
See sprouting plants enrich the plain and wo
For physic some, and some design'd for food.
See fragrant flowers, with different colours dy
On smiling meads unfold their gaudy pride.
&c.

438. It must not then be forgotten, design of the beautiful flowers which c earth is to create the seed of future tre the leaves, or corolla, of the flowers are protections of the delicate pistil, stam germen; that in this last are produced th

nd that for their protection is provided the ericarp, which we call the fruit.

Go, mark the matchless workings of the Power
That shuts within the seed the future flower;
Bids these, in elegance of form excel,
In colour these, and those delight the smell;
Sends Nature forth, the daughter of the Skies,
To dance on earth, and charm all human eyes.

COWPER.

439. Linnæus seized on the variations in th umber of the stamens as a means of *classing* he vegetable kingdom into *twenty-four* deno inations.

Those flowers having one pistil, and but one tamen, he called *mon-andria;* those of two sta- ens he called *di-andria;* three, *tri-andria;* o on up to twenty stamens, and above twenty, *olyandria.*

When he found stamens in one flower, and istils in another, on the same plant, he called hem *diœcia;* and on different plants, *poly-amia.* When altogether invisible, *crypto-amia.*

440. Nothing can be more easy than to re- ember the names of these 24 classes; they re,

1. *Monandria,* one stamen.
2. *Diandria,* two stamens.
3. *Triandria,* three stamens.
4. *Tetrandria,* four stamens.
5. *Pentandria,* five stamens.
6. *Hexandria,* six stamens, all of equal ength.

7. *Heptandria*, seven stamens.
8. *Octandria*, eight stamens.
9. *Enneandria*, nine stamens.
10. *Decandria*, ten stamens, [illegible]
11. *Dodecandria*, twelve stamens [illegible] on the receptacle.
12. *Icosandria*, twenty or more [illegible] upon the calyx or corolla.
13. *Polyandria*, many stamens.
14. *Didynamia*, four stamens, [illegible] short.
15. *Tetradynamia*, six stamens, [illegible] short.
16. *Monadelphia*, filaments unit[illegible] but separate at top.
17. *Diadelphia*, filaments un[illegible] sets.
18. *Polyadelphia*, filaments un[illegible] or more sets.
19. *Syngenesia*, filaments unite[illegible] stamens.
20. *Gynandria*, stamens inserted [illegible] til, or on a pillar elevating the pi[illegible]
21. *Monoecia*, stamens and pist[illegible] corolla upon the same plant.
22. *Diecia*, stamens and pist[illegible] corolla, upon different plant.
23. *Polygamia*, [illegible] situatio[illegible] only, [illegible]
24. *Cryptogamia*, [illegible] and [illegible] spicuous.

and that for their protection is provided the pericarp, which we call the fruit.

Go, mark the matchless workings of the Power
That shuts within the seed the future flower;
Bids these, in elegance of form excel,
In colour these, and those delight the smell;
Sends Nature forth, the daughter of the Skies,
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When he found stamens in one flower, and pistils in another, on the same plant, he called them *diœcia;* and on different plants, *polygamia.* When altogether invisible, *cryptogamia.*

440. Nothing can be more easy than to remember the names of these 24 classes; they are,

1. *Monandria*, one stamen.
2. *Diandria*, two stamens.
3. *Triandria*, three stamens.
4. *Tetrandria*, four stamens.
5. *Pentandria*, five stamens.
6. *Hexandria*, six stamens, all of equal length.

7. *Heptandria*, seven stamens.
8. *Octandria*, eight stamens.
9. *Enneandria*, nine stamens.
10. *Decandria*, ten stamens, filaments s-
parate.
11. *Dodecandria*, twelve stamens to nineteen,
inserted on the receptacle.
12. *Icosandria*, twenty or more stamens, in-
serted upon the calyx or corolla.
13. *Polyandria*, many stamens.
14. *Didynamia*, four stamens, two long, two
short.
15. *Tetradynamia*, six stamens, four long, two
short.
16. *Monadelphia*, filaments united at bottom,
but separate at top.
17. *Diadelphia*, filaments united in two
sets.
18. *Polyadelphia*, filaments united in thre
or more sets.
19. *Syngenesia*, filaments united, and fr
stamens.
20. *Gynandria*, stamens inserted on the p
til, or on a pillar elevating the pistil.
21. *Monœcia*, stamens and pistils in separ
corollas, upon the same plant.
22. *Dioecia*, stamens and pistils in dist
corollas, upon different plants.
23. *Polygamia*, various situations; sta
only, or pistil only.
24. *Cryptogamia*, stamens and pistils i

Obs.—I have introduced beneath, a representatio
the pistils and stamens of a few of the first classes;
the pupil will, doubtless, be led to observe them wi
any flowers which fall in his way in his walks or otl
-wise.

1. 2. 3. 4. 5.

411. The Triandria contains chiefly the na
tural tribe of *grasses*; the hexandria, the *lilies*.
The Icosandria contains the *edible fruits*; the
polyandria, has many *poisonous plants*.
The Tetradynamia contains the natural tribe
of *flowers*, which are antiscorbutic.
The Monadelphia is composed chiefly of the
mallow tribe.
Diadelphia consists of the *pea* tribe, which
roduces edible seeds.
Syngenesia possesses the *compound flowers*
And the cryptogamia contains the natural
bes of *ferns*, *mosses*, *sea-weeds*, and *mush-*
ms.

bs.—The first order of the fourteenth class, denomi-
d "didynamia gymnospermia," are all innocent or
lesome: those of the other order, are fetid, narco-
nd dangerous; being allied to a large part of the
n tria monogynia, known to be poisonous, as con-
e henbane, night-shade, and tobacco. The whole
etradynamia is wholesome. Whenever the stamens
ond to grow out of the calyx, they indicate the
fruits of such plants to be wholesome. The papi-

Monœcious plants are wholesome, except the seeds of laburnum; which, if eaten unripe, are violently em and dangerous. Milky plants are generally to be pected. Umbelliferous plants, which grow in dry elevated situations, are aromatic, safe, and often wh some; while those that inhabit low and watery pla are among the most deadly poisons.

442. Other distinctions in each class prod a division of the classes, called *Orders*. A ther division of the orders, founded on disti tions in the nectarium, lead to the *Gene* Other divisions of the genera, in regard to root, trunk, leaves, &c. lead to *Species*; casual differences in species are called *rieties*.

443. The natural substances found in all ve tables are, *sugar* in the sugar-cane, beet, carr &c.; *gum*, or mucilage, which oozes from m trees; *jelly*, procured from many fruits; *t pentine* and *tar* from the pine; *bitters*, fr hops and quassia; and the *narcotic* princi from the milk of *poppies*, *lettuce*, &c.

444. The vegetables of the greatest value man, are those which produce *gluten* or *star* as wheat, potatoes, barley, beans, &c. *Oils* produced by pressing the seeds or kernels vegetables; as olives, almonds, linseed, *Volatile oils* are distilled from peppermint, vender, &c. *Wax* is collected from all flow by bees.

445. *Resins* exude like gum from firs other trees; and are known as balsams, nishes, turpentine, tar, pitch, &c. Of this cl

too, is *Indian rubber*; which is a gum that exudes from a certain tree in South America.

Iron also mixes with the substance of most vegetables; and is the cause of the beautiful colours of flowers. *Pot-ash* is obtained from the ashes of burnt vegetables; as kelp, vine, fern, &c.

Obs.—The classes monœcia and dicecia, which have the pistil and stamens in different flowers, and on different plants, have the pistil fructified by the bees and other insects, which enter the corolla to extract the honey from the nectarium. The pollen in those flowers which have stamens only, falls on their bodies, and is carried by them to the flowers which have pistils only. And it deserves to be noticed, as a proof of the contrivance of the Divine Architect of Nature, that when the pistil is shorter than the stamens, the flowers grow upright, that the pollen may fall from the anthers of the stamens or the stigma of the pistils; but when the pistil is longer than the stamen, the flower hangs downward, that the pollen, in falling, may be caught by the stigma of the pistil.

——— Who can paint
Like Nature? Can imagination boast,
Amidst his gay creation, hues like hers?
And can he mix them with that matchless skill,
And lay them on so delicately fine,
And lose them in each other as appears
In every bud that blows? If fancy, then,
Unequal fails beneath the pleasing task,
Ah! What shall language do? THOMSON.

Four remarkable Exotics.

THE TEA TREE.

THE COFFEE-TREE.

THE TOBACCO-PLANT.

THE SUGAR-CANE.

446. The chemical or elementary p of vegetables, are *carbon*, *water*, and hydrogen (15), and oxygen (85), for th tuent parts of (100) *water*; and azote or (72), and oxygen (28), as the constitue of (100) atmospheric *air*; and *carbon*.

Obs. 1.— Wood burnt in a close vessel till it l smell nor taste, will produce the basis of all matter called charcoal; or, when purified, call which is the most indestructible substance i The diamond approaches the nearest to pure any substance at present known.

2.—It is found, that water is nothing but a co of two airs or gases, one the inflammable or light *hydrogen*, and the other the vital gas called *ox* water may be made by combining these; or, it be separated into these; one hundred parts of composed of *fifteen* of hydrogen, and *eighty-five*

3.—In like manner, the air or fluid in which is found to be composed of 28 parts of oxygen vital air; and 72 parts of nitrogen, or azotic ga due mixture of both, forms the salutary fluid spheric air in which we breathe.

4.—I have explained the meaning of these in this place, in order to illustrate the beauti sions of vegetables which follow. There is n in them; and they may be understood now a when I treat of Chemistry.

447. Vegetables generate, or give out or vital air, in the light or sunshine, by process of their own.

Air, which has been breathed by an deprived of its 28 parts of oxygen, and longer sustain life.

In like manner, a body, while burn prives air of its 28 parts of oxygen, flame will go out.

nimal would die, or a flame go out, when
air so deprived of its oxygen; but a
le will then thrive in it, and will restore
original power of sustaining animal life.
Hence, the oxygen of the whole atmosphere
a due time, be consumed by the breathing of
ind by flame, but for this provision of nature.
es of vegetables give out oxygen in the day-time,
up the due proportion which is necessary to
ort of animal life: the leaves of aquatic and
us plants produce it, however, in the greatest

The saccharine and oily productions of
les are parts of their sap or juices; but
pentine, the bitter, and the acid princi-
e considered as the effect of preparation
etion.

green colour of vegetables arises from the
contain; the rays of the sun extracting
gen from the outer surface, and leaving
bon and hydrogen, which are known to
constituent parts of oil.

Healthy vegetables perspire water, by
ler part of their leaves, equal to one-
f their weight every twenty-four hours;
ch part they also give out oxygen.

Nor do they derive their substance in a
al degree from the matter of the soil in
they grow; but they are created by a
inciple of their own, out of air and water,
the imperceptible matters combined with
water, from which all their distinctions
l, taste, and substance, are derived!

Source of Being! Universal Soul
ven and earth! Essential Presence, hail!

By THEE, the various vegetative tribes,
Wrapt in a filmy net, and clad with leaves,
Draw the live ether, and imbibe the dew;
By THEE, disposed into congenial soils,
Stands each attractive plant, and sucks and swe
The juicy tide, a twining mass of tubes:
At THY command, the vernal sun awakes
The torpid sap, detruded to the root
By wintry winds; that now in fluent dance,
And lively fermentation, mounting, spreads
All this innumerous colour'd scene of things.

451. Some plants exhibit signs of grea
sibility, besides the effects in nearly all a
from the presence or absence of the rays
sun: these are the sensitive plant, whose
fold together on being touched by the
and Venus's mouse-trap, which closes o
insect that goes into it, and stings it to

Obs.—Throughout universal nature, a gradat
beings may be traced; and yet their particular
ences elude the observation, like the various col
the rainbow, blending and mixing with each other.
vegetation ceases, or seems to cease, perception b
and we trace some of the first rudiments, or spark
in the actinia, or sea-anemone, the oyster, and the
The polypus ranks as the first of plants, and the
animals; if its propagation, as some naturalists
can be effected by cuttings, similar to the multipli
of plants by slips and suckers. Then, it ascends th
various gradations of beings, distinguished by mo
larged and active faculties, more perfect and mo
merous organs, to those creatures which approach
nature of man. We behold the distant resembla
his sagacity in the elephant; of his social attachme
the bee and the beaver; and the rude traces of his
in the ourang-outang.

XX. *Of Animated Nature.*

52. Animals are a class of beings differently organized from vegetables; because they have different destinations, have different habits, and have the power of moving from place to place, called the faculty of loco-motion.

See, thro' this air, this ocean, and this earth,
All matter quick, and bursting into birth.
Above, how high progressive life may go!
Around, how wide! how deep extend below
Vast chain of being! which from God began,
Natures ethereal, human, angel, man,
Beast, bird, fish, insect, what no eye can see,
No glass can reach; from Infinite to thee,
From thee to nothing. POPE.

Obs.—The principal object of the study of natural history, is to teach us the characteristics, or distinctive marks of each individual natural object, called *classification*. To distinguish a *species* from all others that exist in nature, it is necessary to express in its characters almost the whole of its properties. A number of species brought together, constitutes a *genus* or tribe. Those properties which are common to all *genera*, compose a character that distinguishes this assemblage or group from all other groups. Such an assemblage is called an *order*. By bringing together such orders as are more nearly allied, we form a more general assemblage, called a *class*; and by the union of several classes, we obtain a higher division, to which naturalists have given the name of *kingdom*.

453. When the all-wise Creator determined on making beings which should be able to move from place to place, he contrived for them a different organization from that of beings which were fixed.

As moveable beings could not have their roots in the ground, he provided them with the cavity

of the stomach, in which they were to
about what should be equivalent to the
plants: and the suckers of their nutrime
tering in that cavity, were destined to
the roots of plants in the soil.

454. Hence, in all animals, exists the n
of eating frequently, to fill the cavity
stomach; hence the folly and mischief o
it with heterogeneous and unnatural subs
it being the object of nature simply to
from the matter in the stomach a single
milky substance called *chyle*; no othe
but chyle being admitted into the sani
tem, the rest being rejected and expelle

455. As animals were intended to mov
the perfect are therefore provided with
see objects which might endanger thei
ence; with *ears* to hear, for a similar
with a *voice* to warn others, or to obtai
ance in danger.

Hence, also, they were provided with th
of *smelling* and *tasting*, to discriminate
which was proper for the stomach; and
sense of *feeling*, or *irritability*, to sect
identities, and excite them to action.

And though things sensible be numberless
But only five the senses' organs be;
And in those five, all things their forms e
Which we can touch, taste, smell, or hear,

456. The organs of sense and the p
volition proceed from the head and
the nerves, which direct the muscles
done; but the functions of animal life

tained by a simple, yet wonderful arrangement in the stomach and cavities of the body.

The *heart* is the centre of a thousand tubes, called *arteries*; and by its never-ceasing contractions, it carries the blood through them, to all parts of the frame, diffusing every where warmth and life.

457. The blood of a man, thus driven by the contraction of the heart (a force like that by which water is driven out of a syringe or bladder), weighs 30 pounds; and, as this is the stock of the precious fluid possessed by each of us, and our lives depend on its constant circulation, it is not allowed to remain at the extremity of the arteries, but is there taken up by another set of tubes called *veins*, and by them brought back again to the heart.

458. Thus, there is a constant circulation, outward and inward, of this same blood, at the rate of an ounce to each contraction, from the heart through the *arteries*, and back to the heart by the *veins*. To warm, revive, nourish and keep up its quantity, there are various and wonderful, but very simple contrivances.

Were once the energy of air deny'd,
The heart would cease to pour its purple tide;
The purple tide forget its wonted play,
The pulse again pursue its curious way.

459. The heart consists of four cavities, from two of which called the left *ventricle*, the blood is driven into the arteries through the body; by the other, called the *right auricle*, it is received again by the veins: it then passes into the

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about what should be equivalent to the soil
plants: and the suckers of their nutriment
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> Were once the energy of air deny'd,
> The heart would cease to pour its purple tide;
> The purple tide forget its wonted play,
> Nor back again pursue its curious way.

459. The heart consists of four cavities, from one of which called the left *ventricle*, the blood is driven into the arteries through the body; by another, called the *right auricle*, it is received back again by the veins: it then passes into the

right ventricle, whence it is forced into lungs.

Having there been revivified by coming i contact with the air, it is carried back by a of veins into the *left auricle*, and, from thes into the *left ventricle*, where it began its cour it is then again forced into the arteries, brou back by the veins, &c., till the end of life.

400. The *lungs* are a large spongy substa filling nearly the whole cavity of the chest, wi rises as they fill, and falls as they empty, in spiring air through the mouth and nostrils.

The act of respiration is performed about times in a minute; and about 40 cubic inc of air are respired every time; of whic inches of oxygen are absorbed by the blood the lungs, producing, at the same instant, degrees of vital heat, and restoring the vein blood to its bright red colour.

Obs.—The *lights* used in families to feed cats, are lungs of sheep or oxen, and are exactly similar to lungs of man. On inspection, they will be found t wonderfully adapted to their design of bringing the in contact with the blood. Any rupture in this te fabric, or defect in their action, leads to that fatal of diseases, called Consumption.

401. Four thousand times in every hour, e cavity of the heart is called into action: and the blood in the body passes through the h 14 times in every hour.

The arteries, into which it is forced, bra in every direction through the body, like roots, branches, and leaves of a tree, run through the substance of the bones, and e

part of the animal substance, till they are lost in such fine tubes as to be wholly invisible.

462. In this manner, they distribute nourishment; supply perspiration; and renew all the waste of the skin; and, by passing through glands in every part of the body, all the various animal secretions are elaborated.

In the parts where the arteries are lost to the sight, the veins take their rise, and in their commencement are also imperceptible. The blood is then of a dark colour; and, as it returns to the heart with a less impetus, there is always twice as much blood in the veins as in the arteries.

463. As the blood, in this discoloured state, has lost some of its vital power, it is driven through the lungs, and its colour is restored, but on its passage back to the heart, it also receives a supply of a new fluid extracted from the food of the animal in the stomach and intestines.

The loss of weight in a human body by perspiration in 24 hours is about four pounds; and what is gained by the inspiration of air into the lungs, is lost by the expulsion of moisture, and of gas generated in the lungs.

464. The motion of the lungs is preserved by that of the chest containing them; that of the heart, may be felt on the left breast; and the circulation of the blood, by the action of the pulse in various parts of the body, and particularly at the wrist.

In children, the pulse gives 120 strokes in a

minute; at 20 years, about 75; at 30, a
70; and in old age, 60 or 50.

465. For the purpose of renewing and
ribbing the blood, food is taken in at the mo
macerated by the teeth, and mixed with
saliva; it is then carried into the stomach
bag like a highland bag-pipe,) where it is
solved into a soft pap by a powerful li
called the gastric juice.

466. This pap is then drawn from the
mach into the intestines; where, by means
liquid called bile, it is separated into a w
milky liquid called *chyle*, and into the e
ment.

The chyle is taken up, or absorbed, by
riads of fine tubes called the *lacteals*, w
carry it to a main-pipe called the thoracic d
This pipe ascends to the throat, wher
empties the chyle into a large vein, and h
mixed with the blood, is conveyed to the h

467. Of such subtle and wonderful con
ance is the organization of man! Similar,
is the construction of the whole of animated
ture, from the greatest to the smallest.

Within the package of the skin, and case
to life and comfort, are numerous bones
strength; hundreds of muscles and tendons
action; nerves spread every where for se
tion; hundreds of arteries, to carry out
blood; hundreds of veins to bring it
again; and hundreds of glands performing
kinds of secretions; besides an infinite num

ber called lacteals and lymphatics, to ab-
nd convey nutriment to the blood.
Such being the complex construction of
l bodies, is it not rather wonderful that
e 70 or 80 years, than that we endure no
r? When it is considered also, that a mus-
a bone out of place, a vein or artery stopt
circulation, or a nerve unduly acted upon,
es disease, pain, and misery; is it not won-
l, that we enjoy so large a portion of health
pleasure?
ould not such considerations teach us the
of prudence and temperance?

ch, in yon stream of light, a thousand ways,
ward, and downward, thwarting and convolv'd,
quivering nations sport; till, tempest-wing'd,
rce Winter sweeps them from the face of day!
n so, luxurious man, unheeding pass
idle summer-life in fortune's shine!
asion's glitter! Thus they flutter on
m toy to toy, from vanity to vice; —
, blown away by death, oblivion comes
ind, and strikes them from the Book of Life.

THOMSON.

9. The *nerves* are soft white chords which
from the *brain*, the focus of sensation, and
ose themselves in branches through all parts
e body. Impressions are received by the
s from the adjacent organs of sense; and
rain exercises its commands over the mus-
and limbs by means of the nerves.
ans, the body is enabled to avoid what is
ful, to flee from danger, and to pursue every
g useful and agreeable.

Obs.—Trees and vegetables have no *nerves or vium*; because, as they are unable to move and danger, they could be of no use to them. The proj ject of vegetable organization, appears to be to f food to animated nature; and the wisdom of Prov is in nothing more evident than in the variety, someness, and abundance of vegetable provisions.

470. The *ear* is placed in the most con ent part of the body near the brain, the co seat of all the senses, to give more speed formation.

In man it is of a form proper for the posture of his body; in birds, of a form p for flight, and not protuberant; in quadru its form is, in some, large, erect, and ope others, covered; in subterraneous quadru the ears are short and lodged deep.

471. The structure of the ear is adm contrived to collect the undulations of a and to convey them to the sensory in the The first part is the auricle, or extern formed to stop and collect the sonorus u tions, and convey them to the concha, or capacious round cell, at the entrance of th Persons, whose ears are cut off, have a con hearing, and are obliged to form a cavity the ear with their hand.

In the interior is the auditory passage, ously tunnelled and turned, to give sou easy passage, and prevent their too furiou saulting the more tender internal parts.

472. To prevent the entrance of noxio sects, this passage is secured with a bitte seous substance, called ear-wax. The nex

cipal part is the membranum tympani, or drum of the ear, with its inner membrane, the four little appendant bones, and the three inner muscles to move them, and adjust the whole system to hear loud or soft sounds.

The passage behind the drum of the ear, is called the vestibulum, being the entrance to two other cavities, called the labyrinth, and the second cochlea, from its resemblance to a snail-shell.

473. The principal organs of the sense of *smelling* are the nostrils and olfactory nerves; the ramifications of which are distributed throughout the nostrils.

Smelling is performed by the odorous effluvia in the air, being drawn into the nostrils by inspiration, and struck with such force against the olfactory nerves, as to shake them, and occasion ideas of sweet, fœtid, sour, and aromatic.

474. The *taste* is that sensation which all things give to the tongue; but some consider the palate, the upper part of the roof of the mouth, to be the instrument of taste.

The Creator seems to have established a very intimate union between the eye, the nose, and palate, by directing branches of the same nerves to each of these parts, by which means there exist all the necessary guards against pernicious food; since, before it is admitted into the stomach, it undergoes the trial of two of the senses and the scrutiny of the eye.

475. *Feeling* is the sense by which we acquire ideas of solid, hard, hot, cold, &c.

Some consider the four other senses n
modifications of *feeling*.

The immediate organs of feeling are
ramidal papillæ under the skin, which a
soft, medullary, nervous prominences,
every where under the outermost skin.

Feeling is the most universal of our
spiders, flies, and ants, have this sense i
perfection than man. In blind persons,
fect of sight has been supplied by the
site touch, or sense of feeling.

476. From these five senses, flow all
sitive perceptions, the result of experien
all the various habits, qualities, passi
powers of animals.

Certain practices called *instincts*, no
parent result of experience, *appear* to
long to some animals, contrived by s
known means of that all powerful Creato
wondrous and incomprehensible works
with rapture and devotion the being
has qualified to examine and estimate t

Obs.—To follow this wonderful scheme of
into all its ramifications and variations, and t
its analogies, would fill hundreds of volumes, a
ages of observation; having, therefore, given t
general idea of animated existence in its relati
getables, I shall proceed to a brief enumerati
Linnæan classes; referring my young students
ley's Animal Biography, to Buffon's Natural
Mavor's Abridgment, and to a multitude of oth
on such subjects.

477. As a prop work, or substantial f
the body, the *bones* are provided.

That the bones might not interfere with motion, they are provided with hinges or *ligaments*.

That the ligaments might work smoothly into one another, the joints are separated by gristles or *cartilages*, and provided with a gland for the secretion of oil or *mucus*, which is constantly exuding into the joints.

478. There are 248 separate bones in the human body, classed under those of the head, the trunk, and the extremities.

The skull, or cranium, consists of eight pieces, and serves as a vault and protection to the brain. There are also the cheek-bones, the jaws, and 32 teeth imbedded in them.

The head is joined to the trunk by the vertebræ, consisting of several short bones, to the upper part of which it is fastened by a hinge-joint, and turned in the socket of the next lower one by suitable muscles to the right or left.

479. In the front and centre of the trunk is the breast-bone, extending from the neck to the *abdomen*; and opposite to it, in the *back*, is the *spine* or back-bone, which extends from the skull to the bottom of the loins, and is a long chain of separate short bones, called vertebræ.

These serve as the support of seven hoops or *ribs*, which are inserted in them, and form the chest or *thorax*, in which are the *heart*, *lungs*, &c.

Beneath them, inserted in the spine only, and extending but half way round the body, are five

false ribs. The hip bones, with other bones attached, supporting the abdomen, are called the *pelvis*.

480. From the neck to the top of each arm, a bone extends on each side, called the collar bone, and the blade bones are independent supporters of it. The bone extending from the shoulder to the elbow is called the *humerus*.

From the elbow to the wrist are two bones, the outer of which is the *radius*; the inner the *ulna*.

The thigh-bone is called the *femur*; the knee, the *patella*; and the leg has two bones like the arm, the inner called the *tibia*, and the outer the *fibula*.

481. The Animal Frame is constantly exhausted and renewed; so that every particle of the human body is changed in the compass of a year!

Nor is it less surprising that so many different substances as compose every animal body, should also be secreted by the glands from the same blood, than that that blood may, in every instance, be traced to grass for its origin.

Obs. Those functions by which aliment is assimilated for the nourishment of the body, are *digestion*, *absorption*, *circulation*, *respiration*, and *secretion*; and the effect of such assimilation is called *nutrition*.

2. The food received into the stomach after mastication by the teeth, and being mixed with *saliva*, is converted into *chyme* by the gastric juice; the chyme passes into the intestines, where it is converted into *chyle* and *excrementitious matter*; which last, being ejected by the use of *life*, is evacuated from the bowels; whilst the chyle is absorbed by the *lacteals*, and conveyed into the *blood vessels*.

3.—The absorbent system consists of the lacteals, lymphatics, the thoracic duct, and the glands called conglobate throughout the body.

4.—*Glands* are organic bodies consisting of blood-vessels, nerves, and absorbents, intended for the secretion or alteration of particular fluids. They are divided into four classes, simple, compound, conglobate, and conglomerate; the orifices of glands are said to be peculiarly irritable.

5.—*Secretion* is the process by which various fluids are separated from the blood by means of the glands. The secretions are divided into the saline, as sweat and urine; the oleaginous as the fat, cerumen of the ear, &c.; the saponaceous, as bile and milk; the mucous, as on the surface of membranes, &c.

6. *Sensibility* is the faculty of perception by the contact of an extraneous body; and this principle is generally diffused in our corporeal organs, but in different degrees. That modification of animal matter, in which sensation appears peculiarly to exist, is termed *nervous*.

7.—*Motion* is effected by the muscular fibre contracting by volition; but the will can only exercise this power, through the *medium* of the nerves. *Irritability* is the power of contraction, inherent in our bodily organs, but not liable to be influenced by the will.

482. All the senses of animals, and all their varied powers of action, are exactly adapted to their different species of existence. What is food for one, is poison to another; and every one finds provision according to its natural habits.

Every thing, also, is in exact proportion; and every provision of nature harmonizes with the corresponding desires and wants of animals.

Nature's unnumber'd family, combine
In one beneficent, one vast design;
E'en from inanimates to breathing man,
An Heaven-conceived an Heaven-erected plan;

Onward, from those, who soar or lowly creep,
The wholesome equipoise through all to keep;
As faithful agents in earth, sea, and air,
The Lower World to watch with constant care;
Her due proportion wisely to conserve;—
A wondrous trust, from which they never swerve.

PRATT'S Lower Wo

483. Linnæus divides Animated Nature in

1. QUADRUPEDS (Mammalia), of which th are already known to man about 230 species

2. BIRDS, of which there are about 1,0 species.

3. AMPHIBIOUS ANIMALS, of which th are about 100 species.

4. FISHES, of which there are about 1 species.

5. INSECTS, of which there are 2,000 spec

And 6. WORMS, of which there are 1 species.

484. The first class of animated beings, cal *mammalia*, comprehends all those that suc their young; and have warm red blood flow in their arteries.

Their bodies, for the most part, are cove with hair, in quantity proportioned to the mate they inhabit. Beneath this covering, skin of various thickness, inclosing a frame skeleton of bones, acted upon by a system muscles and tendons, which are put in mot by nerves communicating with the organ sense and the will of the animal.

They have *Blood*, for Life; *Bones*, Strength; *Muscles*, for Motion; and *Ner* for Sensation.

.quapus divides mammalious animals, or
ich suckle their young, into *seven* or-
hich are chiefly regulated by the num-
situation of the teeth.

mates, or animals having two canine and
ting teeth, and furnished with two pec-
ts. To this class belong man, the ape,
cauco, and the bat.

uta, or animals which have no cutting
either jaw; as the elephant, the sloth,
ater, &c.

æ, or animals whose cutting teeth vary
to two. This order includes most of
idable rapacious quadrupeds; as the
tiger, the bear, &c.

ires, or animals which have only two
and no canine teeth; as the hare kind,
se, the squirrel, &c.

ora, or animals which are hoofed, and
cutting teeth in the upper jaw, in-
the camel, the deer, the sheep, the ox-
c.

luæ, or quadrupeds with cutting teeth
jaw, as the horse, the boar, &c.

æ, or animals whose teeth greatly vary
ent genera. This order comprehends all
e tribes; which, from certain similari-
tructure, are arranged under the class
upeds.

Birds, the *second* class, constituting
vered with feathers, have two wings to
a tail to direct their flight, and a hard
l. Their bones are hollow and light;

and they are, in every respect, made for ma
their way through the air with the least r
ance. Many tribes migrate, at certain sea
from one country to another, and no less
nineteen tribes arrive in England in the sp
and leave us in the autumn; and ten othe
rive in autumn and leave us in the spring.

> How loss my admiration
> To view the structure of that little work
> A bird's nest. Mark it well within, without;
> No tool had he that wrought; no knife to cut;
> No nail to fix; no bodkin to insert;
> No glue to join; his little beak was all;—
> And yet how neatly finished! What nice hand,
> With every implement and means of art,
> And twenty years' apprenticeship to boot,
> Could make me such another? Fondly, then,
> We boast of excellence, whose noblest skill
> Instinctive genius foils.

497 There are six orders of birds:

1. The *Accipitres*, or rapacious kinds
condors, vultures, eagles, and hawks.

2. *Picae*, or the pye kind, as parrots,
crows, &c.

3. *Anseres*, or the duck kind, as the
geese, &c.

4. *Grallae*, or the crane kind; as storks,
flamingoes, &c.

5. *Gallinae*, or the poultry kind; as
cocks, turkeys, partridges, &c.

And 6. *Passeres*, or the sparrow kind
pigeons, larks, blackbirds, nightingales,
lows, &c.

> But who the various nations can declare
> That plough with busy wing the peopled air?

ve, cleave the crumbling bark for insect-food;
ve, dip the crooked beak in kindred blood;
ve, haunt the rushy moor, the lonely woods;
ve, bathe their silver plumage in the floods;
ve, fly to man, his household-gods implore,
l gather round his hospitable door,
it the known call, and find protection there
m all the lesser tyrants of the air.
tawny eagle seats his callow brood
h on the cliff, and feasts his young with blood.

BARBAULD.

). The *third* class is constituted of *Am-*. These have a naked or scaly body, ed teeth, and no fins.

ere are four orders:

Reptiles; as the crocodile, tortoise, lizard, &c.

Serpents; as the rattle-snake, boa constrictor, viper, &c.; some of which are harmless.

Meantes; as the siren.

Nantes; as torpedoes, sharks, &c.

). The *fourth class* of animated beings, are ; the inhabitants of a different element man, but not less wonderful in their oration, nor less various in their forms and s than the other classes.

ny hundred species of fishes, which reside e unfathomable depths of the ocean, are lless unknown to man; and he knows little e real habits and economy even of those i are the most familiar to him.

.—The eye can reach but a very short way into pths of the sea; and that only when its surface is and serene. In many seas, it perceives nothing *right sandy plain*, at bottom, *extending for several miles*, without an intervening object.

at, in [illegible] is very
[illegible] of water
[illegible] marine plants, and
[illegible] abitation, sometimes
[illegible] Here are seen the
[illegible] sea-mushrooms, and
madrepores, [illegible] covering every part of the
other marine productions, [illegible] parts of the sea near America
bottom.—The bed of many [illegible] a very beautiful appear-
presents a very different, tho[illegible] ables, which makes it
ance, being covered with [illegible] beneath are seen thou-
look as green as a meadow; [illegible] animals, feeding,
sands of turtles, and other sea-[illegible]

2.—"Were it not (says Hawkins) for the moving of
the sea, by the force of winds, tides, and currents, it
would corrupt into life! An experiment of this I saw
when lying with a fleet about the islands of Azorn
almost six months; the greater part of which time w
were becalmed. Upon wh[illegible] all the sea became so r
plenished with various sorts [illegible] jellies, and forms of s
pents, adders, and snakes, as seemed wonderful; so
green, some black, some yellow, some white, some
divers colours, and many of them had life; and s
there were a yard and a half, and two yards lo
which, had I not seen, I could hardly have belie
And hereof were witnesses all the companies o
ships which were then present; so that a man c
hardly draw a bucket of water clear of some corrupt
Mr. Boyle was also assured by one of his acquaint
who had been becalmed for about fourteen days,
Indian ocean, that the water, for want of motion,
to stink with life; and that, had the calm con
much longer, the stench would probably have p
him. These assertions may be supported by our
ledge that animal food left to corrupt, will e
life.

490. Fishes are divided into four orde

1. *Apodes*; such as have no ventri
as eels, congers, &c.

2. *Jugulares*; such as have the ven
placed before the pectoral, as cod, &c.

1. *Thoracici;* those that inspirate by the gills
y, as the perch, &c.
And, 4. *Abdominales;* those having ventral
behind the pectoral in the abdomen, as
e, salmon, &c.

191. Insects, the *fifth* class of animated be-
s, are, in many respects, the most entitled to
wonder and attention, on account of the
azing variety of their forms and habits.
Those *animalcula*, of which a thousand might
ace on the point of a needle, are as curiously
beautifully, and as perfectly formed, as the
rest animals in nature.

Myriads of creatures (each too nicely small
Bare sense to reach) for thy inspection call;
In animalcules, germs, seeds, and flow'rs,
Live, in their perfect shapes, the little pow'rs.
Vast trees lie pictured in their slend'rest grains:
Armies one wat'ry globule contains.
Some, so minute, that, to their fine extreme,
The mite a vast leviathan will seem—
That yet, of organs, functions, sense partake,
Equal with animals of largest make;
In curious limbs and clothing they surpass,
By far, the comeliest of the bulky mass. THOMSON.

bs.—Insects are small in our eyes but not so to the
ator, who views *infinity* itself at a glance; and, com-
ed with infinity, an emmet is as large as the solar
em. Largeness and smallness are terms as relative
p or down.

192. Insects, viewed through a microscope,
uld teach children to respect their lives and
ppiness, and never, in wantonness, to destroy
most apparently insignificant. The child
o treads upon a worm, or destroys a fly in
rt, gives indication of a wicked, cruel, or
oughtless mind.

The poor beetle, that we tread u[illegible],
In corporal suff'rance, feels as great a pang
As when the giant dies. INSECTA

Obs.—The influence of kind treatment on the [illegible] animals, is beautifully described by PRATT, [illegible] "Lower World:"

Kindness can woo the lion from his den—
(A moral lesson to the sons of men!)
His mighty heart in silken bonds can draw;
And bend his nature to sweet Pity's law.
Kindness can lure the eagle from her nest,
'Midst sun-beams plac'd, content with man to
Can make the elephant, whose bulk supplies
The warrior-tower, compassionate, as wine;
Make the fell tygress (from her chain unbound
Herself unfed, her craving off-spring round,)
Forget the force of hunger and of blood,
Meekly receive from man her long-wish'd food
Take too the chastisement, and (if 'tis just)
Submissive take it, crouching to the dust.
Kindness can habits, nay, the nature change,
Of all who swim the deep, or forests range;
And for the mild, *domestic* train, who come,
The dog—the steed—with thee to find a home;
Gladly they serve thee; serve thee better too,
When only happy beings meet their view.
Ah! then, let gentler accents, gentler looks, an[illegible]
The thunders of thy voice, the lightnings of thin[illegible]

493. The class of insects is divided into [illegible] orders, viz.

a. Coleoptera, or insects having four wi[illegible] the two superior ones being crustaceous, furnished with a straight suture.

b. Hemiptera; insects smaller than the [illegible]ceding, with four wings: the two superior [illegible] crustaceous, and the interior edges lying upon the other.

c. Lepidoptera; insects with four wings [illegible] of them imbricated *with* scales

d. Neuroptera; insects having four wings interwoven with veins, like a piece of net-work, and no sting.

e. Hymenoptera, insects agreeing in their characteristics with the preceding, except that these are armed with a sting.

f. Diptera, insects having two wings, and two elevated alteres (or balances) behind each.

g. Aptera, insects destitute of wings.

494. Every *insect* is furnished with a head, tennæ, or horns, and feet. All insects, likewise, have six or more feet. They respire through pores on their sides, called spiracles. Their skin is extremely hard, and serves them instead of bones, of which they have none.

The head also, the trunk, the proboscis, the mandibles, the breast, the belly, the limbs, the tail, and the wings, are all objects of notice to the entomologist.

See the proud giant of the beetle-race!
What shining arms his polish'd limbs enchase!
Like some stern warrior, formidably bright,
His steelly sides reflect a gleaming light!
On his large forehead, spreading horns he wears
An high in air, his branching antlers bears;
O'er many an inch, extends his wide domain;
And his rich treasury swells with hoarded grain.

BARBAULD.

495. *Worms* are, according to the Linnæan system, the *sixth* class. Some of them have only two senses; others, no head; and most of them, no feet.

They are divided into five orders:

1. *Intestinal worms;* as tape-worms, leeches,

2. *Mollusceous worms*; chiefly inhabiting the
sea.
3. *Testaceous worms*; as muscles, cockles,
oysters, snails, &c.
4. *Zoophytes*; between animals and vegeta-
bles.
And 5. *Animalcules*; generally invisible
the naked eye.

406. The Indian thread-worm eats into
skin in the West-Indies, and its extraction
sions great trouble. The furia does the same
Sweden. The common hair-worm is said
occasion whitlows. Garden, or dew-worms
useful to vegetation, by loosening the soil
heads and tails of snails will grow again.
Nereis is the sea glow-worm.

Full Nature swarms with life: one wondrous mass
Of animals, or atoms organized,
Waiting the vital breath, when Parent-Heaven
Shall bid his Spirit blow. The hoary fen,
In putrid streams, emits the living cloud
Of pestilence. Thro' subterraneous cells,
Where scorching sunbeams scarce can find a way,
Earth, animated, heaves. The flowery leaf
Wants not its soft inhabitants. Secure,
Within its winding citadel, the stone
Holds multitudes. But chief, the forest-bough
That dance unnumber'd to the playful breeze,
The downy orchard, and the melting pulp
Of mellow fruit, the nameless nations feed
Of evanescent insects. Where the pool
Stands, mantled o'er with green, invisible,
Amid the floating verdure, millions stray.

407. Young snails come forth with t
on their backs; and the shells are en
the animal, by means of a secretion f

pose, by which also they repair the shells when broken. The shell so effectually preserves them, that they have revived in water after being kept dry in a box for twenty years; and even after being immersed in boiling water.

Corals are shells produced by an insect within them: and they grow in such quantities, and to such heights in some seas, as to create islands inhabited by men. The Friendly Islands, in the Pacific Ocean, were thus raised by corals from the depth of that sea. Ships have often been lost on coral-rocks.

Obs. 1.—The wisdom of BEES, the harmony of their government, their persevering industry, and wonderful economy, have been celebrated in every age. Their combs, or nests, are composed of cells or six-sided figures, so finely finished, that the most expert workman would find himself unqualified to construct a similar habitation. By applying hexagonal cells to the sides of each other, no void spaces are left between them; and, though the same end might be accomplished by other figures, yet they would require a greater quantity of wax. A comb consists of two rows of cells applied to each other's ends. This arrangement both saves room in the hive, and gives a double entry into the cells: the bases of the cells in one row of a comb, serving for bases to the opposite row. It is difficult to perceive, even with the assistance of glass-hives, the manner in which bees operate. They are so eager to afford mutual assistance; and, for this purpose, so many of them crowd together, that their individual operations can seldom be observed. It has, however, been discovered, that their two teeth are the instruments they employ in modelling and polishing the wax. The combs are generally arranged in a direction parallel to each other. An interval, or street, between the combs, is always left, that the bees may have a free passage, and an easy communication with the different combs in the hive. These streets are sufficiently wide, to allow two

bees to pass one another. [illegible] el streets, to shorten their journey w[illegible] eave sev- ral round cross-passages, w[illegible] e always covered. The honey-bees not only labour [illegible] mon with astonishing assiduity and art, but their whol[illegible] attention and affection seem to centre in the person of t[illegible] e Queen or sovereign of the hive. When by any accid[illegible] nt she dies, the whole community are instantly in [illegible] rder—all their labour cease; no new cells are constr[illegible] ted; and neither hone[illegible] nor [illegible] coll[illegible] d.

[illegible] fervent bees [illegible] delic[illegible] around, athwart, [illegible] nsy nations fly, [illegible] inserted tube [illegible] the hue, and [illegible] its pure essence, its ethereal soul; [illegible] with bolder wing, they soaring, dare [illegible] le heath, or where the wild thyme gro[illegible] load them with the luscious spoil.

THOMSO[illegible]

2.—The labours of WASPS, though not benefici[illegible] mankind, are not less ingenious nor less worthy of [illegible] ration. Wasps associate in great numbers, and con[illegible] a common habitation with much dexterity and skill [illegible] cells of the wasps are formed of a kind of paper, [illegible] with great dexterity, is fabricated by the animals [illegible] selves. The hole which leads to a wasp's nest is [illegible] an inch in diameter, being a kind of gallery mi[illegible] the insects; the whole nest is of a roundish for[illegible] sometimes above twelve inches in diameter. This [illegible] raneous city, though small, is extremely populou[illegible] middle-sized nest there were at least 10,000 cell[illegible] different stories of combs are always about half [illegible] high; these intervals are so spacious, in propo[illegible] the bulk of the animals, that they may be comp[illegible] great balls, or broad streets. Each of the large[illegible] is supported by about fifty pillars, which, at [illegible] time, give solidity to the fabric, and greatly [illegible] the whole nest. Boys, and even men, are guilt[illegible] and undeserved cruelty to these ingenious ins[illegible] never sting, unless they are irritated and attac[illegible]

3.—The association of ANTS merits no less a[illegible]

hose of bees and wasps. The form of their nest, , is somewhat conical; and, of course, the water, it rains, runs easily off, without penetrating their . Under this hill, there are many galleries or pas- which communicate with each other, and resemble eets of a city. They go to great distances in search visions; and their roads, which are often winding volved, all terminate in the nest.

3. The study of Shells is called *Conchology*. e are more than a thousand species of shells, hey are separated into three divisions — *valves*, *bivalves*, and *univalves*, accordingly e shells consist of *many* parts, of *two*, or *ngle* part.

ultivalves consist of many plates or shells, ected in some species like the different of a coat of mail.

valves consist of two shells, connected by ge; as the muscle, oyster, &c.

d the *Univalves* comprehend those that a regular spiral, which is a numerous di- , including the snail, periwinkle, &c., and also without a regular spiral.

.—Pearls are found in oysters and muscles. They lcareous concretions, formed of the liquid of which ter surface of the shell is composed, and are as of accidental injury to the shell. The Chinese se the number of pearls, by catching muscles, and ating the shells; and then replace the muscles in ter. After a certain time, on opening them again, discover pearls attached to the part injured. The nce of the shells of these animals, when chemically ned, is found to be a mild calcareous earth, depo- n a mass of net-work, composed of animal matter. ining matter, left in the tracks of snails, is this ubstance; which, when deposited in strata above nother, hardens and forms a shell.

9.—Many hundreds of unknown species of m
shells are found in the strata of the earth, the rema
seas and shores now no more.

490. The *polype* is an insect of a sm
jelly-like substance. It shrinks into a r
green spot, if disturbed; but, in its na
form, is a long tube, and has a head and m
from which eight or ten long arms are proje
to seize worms and other insects.

The young issue from its side in a surpri
manner; but, it is the wonderful proper
this insect, that if cut into any number of p
and in any direction, each part will beco
perfect polype in itself!

It may even be turned inside out witho
jury; and the dismembered parts of one p
will unite with those of another, and mak
perfect polype!

500. After man has exerted his eyes to
the smallest insects, he will find, on apply
microscope, others so small, that ten thou
of them are not equal in bulk to the sm
which he can view with his naked eye.

LEWENHOECK tells us of insects seen
microscope, of which 27 millions would eq
equal to a mite, and four millions to a
grain of sand.

501. Yet, each of these animalculæ h
organized body, provided with a heart, l
muscles, glands, arteries, and veins; and
blood and other fluids passing through the

Their vigour and powers of action are
rally superior even to those of larger ani

ne of bees and wasps. The form of their nest, is somewhat conical; and, of course, the water, rains, runs easily off, without penetrating their Under this hill, there are many galleries or pas- hich communicate with each other, and resemble ts of a city. They go to great distances in search alons; and their roads, which are often winding olved, all terminate in the nest.

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cernible, yet they move about with inconceivable relative velocity in the fluids they inhabit without interfering with each other.

603. HUNTER divided all animated nature into single and complicated animals. The simple are those which possess only feeling or the powers of muscular contraction, and the power of absorbing food, as chalk absorbs moisture and appropriating it to nourishment.

The *hydatid*, found in sheep, consists only of a bag filled with water, and has no appearance of animal powers; but, when excited or pricked, *contracts* and shews its *irritability*; while the vital power is *supported* by the nourishment which it receives through its coat.

604. From such simple animals, we trace through all the degrees, up to the complicated and combined powers of body and mind, MAN!

The links are kept up, by the addition of muscles, for additional motions; by other senses for hearing, seeing, &c.; and by various degrees of irritability in those senses.

The blood for renovation circulates through the lungs; and for action through the cause of the heart; secretions take place by the various glands; the contraction of the muscles moves the bones; the nerves convey the effect of the mental secretions to the brain, and there produce the inscrutable powers of sensation, will and judgment.

605. Although animals, in general, are sufficiently distinct from vegetables, yet the gra-

tions of nature are so minute, that many animals are but slightly removed from vegetables, having not more than one or two senses; and, as in some shell fish, have not even the power of loco-motion.

Between these and man, there is a regular succession of that cunning and sagacity which are necessary to preserve and sustain life; yet, between man and most other animals, there is, in mental capacity, as great a difference as between some of those and vegetables.

Far as creation's ample range extends,
The scale of sensual, mental powers, ascends:
Mark, how it mounts to man's imperial race,
From the green myriads in the peopled grass:
What modes of sight, betwixt each wide extreme,
The mole's dim curtain, and the lynx's beam:
Of smell, the headlong lioness between,
And hound sagacious, on the tainted green:
Of hearing, from the life that fills the flood,
To that which warbles thro' the vernal wood!
The spider's touch, how exquisitely fine!
Feels at each thread, and lives along the line:
In the nice bee, what sense so subtly true!
From poisonous herbs extracts the healing dew:
How instinct varies in the groveling swine,
Compar'd, half-reasoning elephant, with thine!
'Twixt that, and Reason, what a nice barrier!
For ever separate,—yet for ever near!

POPE.

A WHITE BEAR.

A TYGER.

A WHALE.

AN EAGLE.

AN OSTRICH.

Obs.—In Art. 127 and 128, are described the tra
formations of insects, from the egg to the worm—the w
to the chrysalis—and the chrysalis to the butterfly.

The following cut represents those four states in
common caterpillar.

THE EGGS, CATERPILLAR, CHRYSALIS, A
BUTTERFLY.

XXI. *Chemistry.*

506. By Chemistry we ascertain the ingredients, component parts, or first principles, of which all kinds of matter are composed.

DEFINITIONS.

1.—***Decomposition*** implies the separation of the elementary substances of which any compound substance is formed.

2.—***Pulverization*** signifies the mere mechanical separation of bodies into smaller ones, without being decomposed into its elementary ingredients.

3.—***Chemical affinity*** affords proof that atoms are compounded in different forms, which coalesce and dovetail together with more or less facility.

4.—The sensible atoms appear *attracted* or *repelled* accordingly as they, or those of the media in which they are placed, are more or less mutually affected.

5.—The substance which decomposes another, is called a chemical *test*, or *re-agent*.

6.—If a salt be dissolved in water, it is said to be in *solution*, and the water is called the *menstruum*.

7.—When water will dissolve no more of any substance, the water is said to be *saturated*.

8.—If we would extract the salt, we must *evaporate* the water by *heat*, with a still, a retort, or alembic; and if the *vapour* from either of these pass through a spiral tube or *worm*, to the *receiver*, we shall have *distilled* water; and the salt will remain in the *still*.

9.—Solid substances are reduced into powders by *trituration*, *pulverization*, and *levigation*; brittle substances are pulverized by means of hammers, pestles and mortars, stones and mullers.

10.—The separation of the finer parts of bodies from the coarser is performed by means of *sifting* or *washing*.

11.—***Filtration*** is a finer species of sifting, performed through the pores of paper, flannel, fine linen, sand, &c. It is employed only for separating fluids from solids.

12.—***Fusion***, or the melting of a solid body, by the action

of heat, requires, according to their severa
cibles of different kinds strong enough to
made of earthenware, porcelain, or a m
and powder of black-lead, or of black-lead

13.—Sometimes crucibles have covers m
ware, but in other cases the fused metal m
to a current of air; for this purpose the
broad and shallow, and are called *cupels*.

14.—*Blow-pipes* are used for directing
candle or lamp against any piece of ore or o
required to be examined; and when oxyge
gas is used instead of common air, the
powerful.

15.—The various degrees of *heat*, or
which are required for the performance
operations, render it necessary that the
also be possessed of a *furnace*.

16.—Chemical combinations are more
fluenced by the agency of powers, called h
attraction and repulsion, but in truth consi
susceptibilities of *motion* in the atoms of
the columns of the media in which they a

17.—When a new substance is produced
bination of two others, the operation is c
When that substance is decomposed, or r
constituents by the assistance of other ch
the operation is termed *Analysis*.

18.—*Elementary bodies* are those wh
modern chemistry has been able to decom
elements.

19.—*Atomic motion* produced by percuss
or by transfer, is the cause of all the va
fire, and caloric.

20. *Temperature* signifies the varied in
lence of intestine atomic motion, which,
the distance of the particles or atoms there
of bodies.

21.—Different bodies change their stat
ferent temperatures or degrees of atomic
mercury, which becomes solid at about
Fahrenheit, boils at about 660°; sulphur,
fused at 218°, boils at 570°; other bodies at

8.—*Resistance*, says Sir Richard Phillips, is a phenomenon of parting with received motion. A body said to be resisted, is merely parting with its motion to the atoms which it encounters in the within which it moves; and as it continues to part ... motion to the radiating media, its gradually diminished energy of motion is, in our language, said to be destroyed by resistance.

9.—*Friction*, says he, like resistance, is a mere phenomenon of parting with motion, but to a fixed body instead of a fluid; and being a variation of percussion, or transfer of motion without change of place, it produces similar phenomena of intestine atomic motion or heat, which, when continued or accelerated, produces all the other phenomena of accelerated atomic motion or heat.

10.—*Crystallization*, he says, is a mere effect of parting with atomic motion, in certain connections with, or relations to, the atoms of the surrounding media, in which the crystallized body is placed.

11.—The following principles should be remembered.

1. *That all fluids are combinations of heat (or transferred motion) with various substances;*

2. *That combustion arises from the action of heat, or motion on the parts of the combustible body; and that the process called burning, is nothing more than the oxygen of the atmosphere uniting with certain parts of the body;*

3. *That oxygen seems to be the acidifying principle; and that all acids are combinations of oxygen with other substances;*

4. *And that all* salts *are combinations of an acid with other substances, called the base of the salt.*

Obs.—Sir Humphrey Davy, in the preliminary observations to his *Elements of Chemistry*, beautifully observes, that "the forms and appearances of the beings and substances of the external world are almost infinitely various, and they are in a state of continued alt[illegible]on. The whole surface of the earth even unde[illegible] ... acted on by moisture and [illegible] it [illegible] ... plants; an immense n[illegible] er [illegible] ... productions ... from ... [illegible] ... these become ... substance[illegible] ... animal matter ... converted [illegible] ... t and beautiful

of the forms of organized life ultimately decay, and are resolved into inorganic aggregates; and the same elementary substances, differently arranged, are contained in the inert soil, or bloom, and emit fragrance in the flower; or become, in animals, the active organs of mind and intelligence. In artificial operations, changes of the same order occur: substances having the characters of earth, are converted into metals; clays and sands are united, so as to become porcelain; earths and alkalies are combined into glass; acid and corrosive bodies are formed from tasteless substances; colours are fixed upon stuffs, or changed, or made to disappear; and the productions of the mineral, vegetable, and animal kingdoms, are converted into new forms, and made subservient to the purposes of civilized life. To trace, in detail, these diversified and complicated phenomena, to arrange them, and deduce general laws from their analogies, is the business of Chemistry."

507. The ancients conceived that there were but *four* elements, or first principles—Air, Water, Earth, and Fire.

The moderns have analyzed these four elements, and have discovered other *elements* of these *elements*, viz. Oxygen, Hydrogen, Nitrogen, Chlorine, Carbon, Caloric, (or atomic motion) Sulphur, Phosphorus, nine Earths, and twenty eight Metals.

Obs. 1. Atmospheric Air is now found to be a compound of *Nitrogen* or *Azote*, and *Oxygen*, which are preserved in a *gaseous* state by *Caloric*.

Water is found to be a compound of *Oxygen* and *Hydrogen*.

Earth is a compound of nine different substances, now called Earths. (See 521.)

And Fire is found to consist of mere *atomic motion*.

2. The forms of matter are well arranged into three distinct classes, by Sir H. Davy. The *first* class consists of *solids*, which compose the great known part of the globe. Solid bodies, when in small masses, retain what-

hanical form is given to them: their parts are with difficulty, and cannot readily be made to r separation; some solid bodies yield to pres- do not recover their former figure when the ng force is removed, and these are called non- lids; others, that regain this form, are called dies. Solids differ in degrees of *hardness;* in degrees of *opacity* or *transparency;* in *density,* weight afforded by equal volumes; and when s are *regular* or *crystallized,* in the nature of m.

nd class consists of *liquids;* of which there are er varieties. Liquids, when in small masses, as- spherical form; their parts possess freedom of hey differ in degrees of density and tenacity; and degrees of opacity or transparency. They y regarded as incompressible; at least a very hanical force is required, to make them occupy eptibly smaller.

d class, *elastic fluids* or *gases,* exist free in the e; but they may be confined by solids, or by fluids, and their properties examined. Their easily moveable; they are compressible and ; and their volumes are inversely, as the mpressing them. All known elastic fluids are it, and present only two or three varieties of ey differ materially in density.

ides these forms of matter, which are easily sub- experiment, and the parts of which may be l as in a state of apparent rest, there are other natter which are known to us only in their states when acting upon our organs of sense, or upon tter, and which are not susceptible of being They have been sometimes called *ethereal* , which appears a more unexceptionable name *nderable substances.* It cannot be doubted that natter in motion in the space between the sun, and our globe; though it is a subject of dis- hether successions of particles be emitted from, venly bodies; or motions communicated by particles in their vicinity, and transmitted by

successive impulses to other particles. *Ethereal* matter differs, either in its nature, or in its affections, from motion, for it produces different effects, radiant heat, and different kinds of light.

508. CALORIC, say many chemists, is a mere name of that element or principle, which, *combined* with various bodies, produces the sensation of *heat*, but, according to the theory of Sir Richard Phillips, there is no such element, and all the phenomena are mere effects of ATOMIC MOTIONS.

Obs. 1. Body, says he, is susceptible of two varieties of motion: (1) a motion or impulse of an aggregate, which occasions it to change its place in regard to other aggregates; and (2) a motion of the *atoms* of an aggregate, created when any impulse from any cause cannot produce commensurate change of place in the aggregate and diffuse the motion, so that, by re-action, the impulse terminates within the body in the mutual actions of its component atoms.

2. Motion of both kinds, says Sir R. Phillips, continues to affect a body, until it has been imparted or transferred to aggregates in contact, or has been diffused or radiated through the medium in which it is immersed, and this law of the equalization of motion, by the contact of moving aggregates and atoms with others susceptible of receiving and diffusing the motion, is the proximate cause of all varieties of material phenomena.

3. Motion appears, therefore, to constitute the life, power, and energy of matter; and is the active soul of the Universe. Matter is its patient, and the relative phenomena of bodies are the results. As it acts on Aggregates by contact, or by impulse, on and through media, it constitutes the object of *Physical Philosophy*; and, as it affects compounds or structures of Atoms, it is the object of *Chemical Philosophy*.

4. When percussion or collision does not produce an equal quantity of aggregate motion in a proportionate change of place in the aggregate; or when the motion

ot be transferred by diffusion, as when a
laid on an anvil, receives the motion of a
hen two pieces of wood are rubbed together,
r-action of the atoms in the iron and wood
ccompanied by the perception of heat, and
phenomena depending on the quantity of
oncentrated, and on the acceleration of the
ated blows, rubbings, or transfers of motion.
ipative motion produces various phenomena
component atoms of the affected body in
another, and to the heterogeneous media
are situated: thus, one quantity creates a
heat, another sensibly imparts that percep-
me of the surrounding media, another con-
l mass into fluids, an acceleration converts
diverging gas, and a further acceleration,
the radiating powers of the surrounding
spaces those media, exhibiting flame and
the solidification of the oxygenous part
and producing subtle radiations on the rare
a fills space, thereby affecting the nerves of
ed with that medium, with the perceptions

rting with each degree of atomic motion
trary series of phenomena: thus gas, on
its heat or atomic motion to other bodies,
l; and liquids, by parting with their heat or
, become solids; and the diffusion of heat
ion on such re-conversion is sensible, when
part of atmospheric air, solidified by
ves out what is called animal heat; and
e, solidified by combustion, or reduced in
pression, gives out heat, and excites the
ght. *Phillips's Synopsis.*

any body (says Sir H. DAVY) is cooled,
maller volume than before; it is evident,
its parts must have approached towards
hen the body is expanded by heat, it is
t that its parts must have separated from
The immediate cause of the phenomena of
motion, and the laws of its communication

are precisely the same as all the laws of the communication of motion.

Since all matter also may be made to occupy a smaller volume by cooling, it is evident that the particles of matter must have space between them; and since every body can communicate the power of expansion to a body of a lower temperature, that is, can give an expansive motion to its particles, it is a probable inference that its own particles are possessed of motion; but, as there is no change in the position of its parts as long as its temperature is uniform, the motion, if it exist, must be a vibratory or undulatory motion, or a motion of the particles round their axis, or a motion of particles round each other.

It is possible to account for the phenomena of heat, if it be supposed that in solids the particles are in a constant state of vibratory motion, the particles of the hottest bodies moving with the greatest velocity, and through the greatest space; that in fluids, and elastic fluids, besides the vibratory motion, which must be considered greatest in the last, the particles have a motion round their own axis, with different velocities, the particles of elastic fluids moving with the greatest quickness; and that, in ethereal substances the particles move round their own axis, and separate from each other, penetrating in right lines through space.

Temperature may therefore be conceived to depend upon the velocities of the vibrations; increase of capacity on the motion being performed in greater space; and the diminution of temperature during the conversion of solids into liquids or gases, may be explained on the principle of the loss of vibratory motion, in consequence of the revolution of particles round their axis, at the moment when the body becomes fluid or aëriform, or from the loss of rapidity of vibration in consequence of the motion of the particles.—*Davy's Chemistry.*

9. In fine, page [illegible]. [illegible] Phillips. Systems of matter subject to regular mechanical laws, acting absolutely or subordinately, generally or locally, on aggregates of atoms, and producing various densities and different degrees of incorporation and affinity in atoms of matter of different constituent forms, are the *proximate causes of all*

is and, as one series of phenomena depends on
e all existing phenomena are, in regard to
ysically fit, compatible, and harmonious: and,
cannot originate its own motion, as in com-
other as the proximate cause of all phenomena,
through the ascending series, at the sublime
USE. *of all motion and all phenomena.*

ARBON is the base of almost all vegeta-
animal substances. Charcoal is impure
and diamond is pure carbon, except a
tion of oxygen with which it has been
be combined. When combined with
it forms carbonic oxyde and carbonic

arbon exists in large quantities in chalk, lime,
From these it is procured in the form of gas,
; sulphuric acid in a certain apparatus, and
r the name of aerated or soda water, which is
ter impregnated with carbonic acid gas. Car-
gas is the choke-damp of mines. Oils, fats,
mpounds of Carbon and hydrogen.

OXYGEN is an element or simple sub-
diffused generally through nature; and
nt combinations are essential to animal
ombustion.

ned with caloric, it becomes oxygen gas:
of atmospheric air contain 28 parts of
gas; and 100 parts of water consist of
n and 15 nitrogen.

Oxygen gas is distinguished from all other ga-
ter by several important properties. Inflam-
stances burn in it under the same circumstances
mon air, but with infinitely greater vividness.
the flame of which has been extinguished, the
remaining ignited, be plunged into a bottle
it, the flame will be instantly rekindled, and
y brilliant, and accompanied by a crackling
a steel wire, or thin file, having a sharp point,
h a bit of wood in combustion, be introduced

into a jar filled with the gas, the steel will take fire, and its combustion will continue to produce a most brilliant phenomenon.

2.—Oxygen gas is respirable; a small animal, confined in a jar filled with this gas, lives four or five times as long as in an equal quantity of common air;—hence it has been called *vital air*.

511. During the burning of any combustible body, the *oxygen* leaves the atmospheric air, and combines with the *calx* or *residuum*, adding to its weight, and forming what is called an *oxyde*, or *an acid*.

Obs. 1.—This process is called *oxygenation*; and if *oxygen* be combined with *sulphur*, *phosphorus*, *carbon*, or any other substance in various degrees, it will produce *oxydes* or *acids* of strength proportioned to the degree of oxygenation; which are distinguished by the terminations *ous* and *ic*; thus, in regard to sulphur and phosphorus, we vary,

1. Oxyde of sulphur;	1. Oxyde of phosphorus;
2. Sulphur*ous* acid;	2. Phosphor*ous* acid;
3. Sulphur*ic* acid.	3. Phosphor*ic* acid.

2.—Combined with metals in various degrees, oxygen produces *oxydes* of different colours; as *grey* oxyde of lead, *red* oxyde of lead, &c.

512. Hydrogen is one of the most abundant principles in nature; and 15 parts of it combined with 85 of oxygen, form *water*.

It is only to be met with in the gaseous form; and, being 12 times lighter than atmospheric air, is employed to fill *balloons*.

It is also *inflammable*, and is the gas called the *fire-damp*, so often fatal to miners. It is the chief constituent of oils, fats, spirits, ether, coals, and bitumen.

Obs.—Hydrogen is always produced from water, and Water is formed by the union of *oxygen* with Hydrogen. Its existence in water is manifested by water in

apour being made to pass over iron wire made
e oxygen of the water then combines with the
ater disappearing, and the hydrogen gas re-

process for filling balloons, is by mixing five
ter with one of sulphuric acid; and, by pour-
xture on iron filings, the light gas, by the de-
n of the water, will rise into the balloon; and
, being 12 times lighter than the atmospheric
e through it.
uretted Hydrogen gas is now very extensively
hting the streets of London and other towns.
d from coals, and purified by passing through
. It is then conveyed into a reservoir, called
ter, and from thence through pipes, to light
uses, churches, theatres, and shops.

AIR-BALLOON.

NITROGEN, or AZOTE, is a substance gene-
used through nature, and particularly
animal bodies.

Nitrogen is not to be found in a solid or liquid state; but, when combined with caloric, it forms *azotic gas*, in which no animal can breathe, or any combustible burn.

Seventy-eight parts combined with 22 parts oxygen, form 100 parts of atmospheric air. In a higher degree of oxygenation, as 30 to 70, it produces nitrous *gas*; and, still higher, nitric *acid*.

Obs. 1.—As oxygen is absorbed during burning or breathing, and as soon as the 22 parts, or nearly, of oxygen are absorbed, the remainder is nitrogen, and becomes *mephitic*, or deadly, being incapable of sustaining life or flame.

2.—The reproduction of oxygen appears in the process of vegetation; healthy plants exposed in the sunshine to air, containing small quantities of carbonic acid gas, destroy that elastic fluid, and evolve oxygen gas; so that the two classes of organized beings are thus dependent.

3.—It has lately been found, that azote generates uric acid, and gravel and stones in the kidneys, and hence animal food be properly be forbidden to persons subject to these afflicting disorders.

514. Chlorine, or Oxymuriatic Acid Gas, is an elementary substance, of a yellowish green colour, and it is this circumstance which suggested its name. Its odour is extremely disagreeable. It is not capable of being respired, and even when mixed in very small quantities with common air, renders the air extremely pernicious to the lungs. When an inflamed taper is introduced into a phial filled with it, the light continues, but of a dull red colour.

Obs. Chlorine has never been found pure in nature; but exists in many compounds; particularly in common salt, and it may even be produced from that substance.

515. Sulphur is an inflammable substance found in the neighbourhood of volcanoes, com-

d with earths and metals, from which it is
rated by sublimation in a furnace.

.—When combined with oxygen, it forms a sul-
e and sulphurous acid. This is usually done by
ng the sulphur in leaden chambers, the floors of
are covered with water, with a quantity of nitre
is, one part to nine parts of sulphur) which as
oxygen for the formation of the acid which is con-
d by the water. The water is then drawn off, evap-
ed by boiling, and afterwards distilled in retorts:
sult is sulphuric acid, or oil of vitriol. Sulphur
ines with hydrogen, the alkalies, the earths, and
s. These combinations are called *sulphurets*.

0. *Phosphorus* is a simple substance,
d in a state of combination with the bones
imals, from which it is extracted.

s tendency to unite with *oxygen* is so great,
it always *burns* in the open air; and bursts
flame, at a degree of heat a little above that
e human body.

combinations with earths and metals are
d *phosphurets*.

.—Many amusing experiments may be performed
it; but great care should be taken, and a basin of
kept at hand, for it will kindle into an unextin-
ible flame by slight friction.

1. Chemists, by separating earths from fo-
matters, and from each other, have disco-
d nine primitive *Earths*, which are not so-
in water or by heat: they are,

Alumine,	*Silex*,
Barytes,	*Strontia*,
Glucine,	*Yttria*,
Lime,	*Zircon*.
Magnesia,	

.—These earths combine with acids, alkalies, oxy-
ulphur, phosphorus, the metals, and with each other,
rious proportions; and four of them merit special
.

1. *Alumine, argil*, or pure clay, is infusible by the greatest heat; but heat makes it so hard as to scratch glass. It readily absorbs water, and also grease; and hence its use, as fuller's earth, in scouring cloths, &c.

2. *Lime*, or calcareous earth, is obtained by applying heat to chalk, marble, lime stone, &c. by which carbonic acid gas and water are expelled, and the lime left as a product.

When used as a cement in building, water is used to make it plastic; and, with the addition of ashes, or sand, to supply carbonic acid, acquires its original hardness.

Lime is also used in tanning, in making sugar and soap; and it forms 80 parts, combined with 20 of phosphoric acid, in 100 parts of animal bones.

Lime is antiseptic; a few drachms, stirred in a cask of impure water, will render the whole perfectly sweet.

3. *Magnesia*, is a soft, white earth, generally found in combination with sulphur. United with sulphuric acid, it forms that sulphate called Epsom salts.

4. *Silex*, or flint, is the principal ingredient of stones, crystals, sand, &c., and cannot be melted by itself in any heat; but in contact with alkalies, as soda or potash, it forms that useful production called glass.

[illegible] The immense stony masses of which the globe is composed, are found in the earth lying in *strata* one above another, a rock of one kind covering another species of rock, this a third, and so on. The arrangement is not arbitrary, but each species occupies its regular place, from the deepest part yet explored, to the surface.

[illegible] Rocks are divided into five classes or *formations*, called *primitive*, *transition*, *stratified*, *secondary*, and *tertiary*.

1. The *primitive* formations of rocks are the lowest, and are supposed to have been chemical precipitations, formed in the chaotic state of the earth; because they have no petrifactions or trace of organized beings. They are chiefly composed of silicone and argillaceous earths, as [illegible], slate, &c.

2. *Transition* rocks are supposed to have been formed during the transition of the earth into a habitable state;

ffer from primitive, in the variety of their colours, in containing the remains of marine animals.

Stratified rocks are disposed in horizontal *strata*; contain the remains of animals and vegetables, and sequently were formed after the creation of animals vegetables.

Alluvial formations consist of the constituent ts of previous rocks, separated by water, air, &c. deposited in beds. These are compounded of sand, el, loam, clay, turf, &c.; and contain plants, s, moss, bones, &c.; likewise petrified wood, and ctons of quadrupeds;—the remains of destroyed lds.

Volcanic formations are minerals thrown out of the ter of a volcano, consisting of pumice-stones, lava, basalte.

523. All Acids consist of certain bases combined with oxygen, which is considered as the neral cause of acidity.

Obs. 1.—Acids excite a *sour* taste on the tongue; change etable blue colours into *red*; and are either *solid*, *liquid*, *gaseous*. Acids unite with water in every proportion, some of them have such an affinity for it, as never to t their fluid state. They also combine with the *alka-*, *earths*, *and metallic oxydes*; forming salts.

2.—Salts may be formed by art; but many exist in ure, ready formed. Salts possess double names; for mple, the *Nitric Acid* combined with *Potass* forms at is called *Nitrate of Potass*.

524. There is also another property in nature, called the *alkaline*, which is distinguished om the *acid* by its burning and urinous taste; d it has the distinct property of converting getable *blues* into *greens*.

The two *alkalies* are *potass* and *soda*; and ere is also a *volatile* alkali called *ammonia*.

Obs. 1.—*Alkalies* and *acids* have the property, when ablued, of neutralizing each other; and hence *acids*, en combined with alkalies, form what are called *utral Salts*.

—Alkalies, mixed with *fats*, make soap; and,
ed, with silex, glass.
Potass is chiefly obtained by burning vegetab
e, &c., and hence called pot-ashes; but
er alkali, is obtained from sea-salt, from natro
l even from mines. Ammonia is obtained fr
l substances, viz. bones and urine; and also
istillation of coals for gas.

525. The several Acids hitherto disc
in number.

Sulphurous,	Arsenic,	Malic,	
Sulphuric,	Tungstic,	Oxalic,	
Nitrous,	Molybdic,	Citric,	
Nitric,	Chromic,	Tartaric,	
Muriatic,	Columbic,	Tartareous,	
Oxy-Muriatic,	Molybdenous,	Benzuic,	
Carbonic,		Camphoric,	
Fluoric,		Gallic,	
Boracic,		Succinic,	
Mellithic,		Suberic,	
Hyper-Oxy-Muriatic.		Mucous,	
		Morazylic.	

526. The principal Acids obta
mixture of oxygen with other su
Oxygen and sulphur, called s
or oil of vitriol.
Oxygen and nitrogen, calle
which dissolves silver, and the
plating with silver.
Oxygen and Chlorine called
acid of sea-salt;—this acid, w
called muriat of soda, which is
of the table.
Query.—Oxygen, and Fluoric,
shire-spar, is called *fluoric* acid,
etching on glass. *Nitro-muriatic*
dissolves gold and platina.

is may combine with two or more substances, and ect is called a triple compound. Thus sulphuric mbined with alumine and potass, forms alum, at of alumine and potass; and Tartar emetic is te of the metal antimony, and potass.

SALTS formed from acids combined kalies, earths, or oxydes, amount to many ds.

ie of which *sulphuric acid*, or oil of vi- rms a part, are—

of Soda,	Sulphate of Magnesia,
— Potass,	——— Alumine,
— Barytes,	——— Iron,
— Lime,	——— Copper, &c.

ie of which *Nitric Acid* are formed, are

of Potash,	Nitrate of Mercury,
- Silver,	——— Copper, &c.

iatic Acid is a component part of

of Soda,	Muriate of Mercury,
— Ammonia,	——— Copper,
— Barytes,	——— Iron,
— Lime,	——— Lead,
— Silver,	——— Cobalt, &c.

muriatic Acid forms a part of

iate of Potass,	Oxymuriate of Mercury,
——— Soda,	&c.

ic and *Muriatic Acid* combined, form Muriates. These are

luriate of Gold,	Nitro-muriate of Cobalt.
——— Tin,	

Metals are seldom found in the earth in state, but generally in combination with , earths, sulphur, and acids. In these of combination, they are called *ores*: e generally found in mines. (*See artillurgy*, p. 16.)

.—Metals are fusible by heat, and when suffered gradually, they crystallize. If they are vola-

tinued in fusion, they absorb a certain portion of oxy[illegible] lose their brilliancy, and become *metallic oxides*. W[illegible] also oxidates metals; its hydrogen being disengaged, oxygen unites with the metal. Metals are soluble [illegible] acids, and may be precipitated from them by alka[illegible] When perfectly fused, they are miscible with each o[illegible] forming *alloys*, and with other substances, as sulp[illegible] phosphorus, and charcoal.

[illegible] In the *reduction* of metals from their oxydes, [illegible] addition of a combustible substance is necessary; [illegible] coal for instance. Iron and platina grow soft be[illegible] they fuse, hence their useful property of being we[illegible] Metals are excellent conductors of electricity. All [illegible] tals are combustible, and some will burn before they [illegible] hot enough to melt.

[illegible] The property which metals possess of b[illegible] combined with each other, renders them very us[illegible] Copper and zinc form brass; lead and tin, pewter

529. The Metals at present known, are 2[illegible] number.

In *Malleable*.	In *Dejectile*.	
	5 Fusible.	13 Fused with Difficu[illegible]
Platina,	Bismuth,	Cobalt,
Gold,	Antimony,	Manganese,
Silver,	Tellurium,	Tungsten,
Mercury,	Arsenic.	Molybdenum,
Copper,		Uranium,
Iron,		Titanium,
Tin,	Chromium.	Columbium, or
Lead		Tantalium,
Nickel,		Cerium,
Zinc.		Cadmium,
		Iridium,
		Palladium,
		Rhodium

530. All *Mineral Waters* are formed by [illegible] solution, or mixture in them, of *oxygen* [illegible] *nitrogen gases*, or of acids, alkalies, and neu[illegible] salts.

phurous acid is found in some mineral
s; *alkali*, or soda, in others; and salts, as
ates, nitrats, muriats, and carbonats of
or lime; and in chalybeate waters, the
onat of iron

—The *test* of the presence of carbonic acid in
neral water is an infusion of *litmus*, which will
ned red by water containing it; and this acid also
he briskness of champaign into whatever it enters,
acidulated flavour to water. Any acid con-
in any water, may be detected by its turning the
ur of violets, red. Alkalies in water may, in like
r, be detected, by turning the infusion of violets,
The infusion of dry violets, or paper stained with
answers best. The infusion of turmeric, or paper
d with turmeric, is rendered brown by alkalies;
dish brown, if the quantity is minute. When the
is temporary, it is volatile alkali. Sulphur and
n may be detected, by the smell and taste. Iron,
eral water, may be detected by Prussiat of potass,
will precipitate it, and tinge it blue. The solu-
galls also is an exquisite test of the presence of
When there is copper in water, it will shew itself
surface of any piece of bright iron put into it. If
, the residuum will tinge copper, *white*.

1. The vegetable kingdom affords ma-
beautiful instances of the chemistry of
e. *Water* may be esteemed the chief pa-
n of vegetables, which reducing it to its
principles, appropriate its *hydrogen* and
n in the formation of their respective con-
nt parts.

, light, and heat, aid the several processes,
t the application of manure not only adds
quantity of nutriment, but at the same
stimulates the vegetating principle to in-
ed action. (See No. 443 to 448.)

12. Vegetable substances, subjected to

FERMENTATION, produce, under differ cumstances, either WINE, from which AL may be obtained, or the ACETIC ACID, vinegar. Besides which the following may be obtained from vegetables: b citric, gallic, malic, oxalic, phosphoric, p tartaric, &c.

533. BITUMENS are certain bodies, have considerable resemblance to resi oils, and are found in subterraneous tions.

Obs. *Naphtha* is a yellow and transparent f latile, strongly smelling, and very light; and f resembles naphtha.

Jet is also a bituminous substance, holding a bon. *Canal coal* is of the same class, but contin earth. *Common coal* has its bituminous consti tersected by plates of carbonate of lime and sulp iron.

533*. Animal substances, although c ing some of the same principles found vegetable kingdom, still manifest consi differences in their respective analyses.

Gelatine, or *jelly*, employed in the arts as abundantly obtained from the skin of animals.

Albumen, is that substance which forms what i the white of eggs.

Mucus has been determined by the same chem instanced in the thickening substance contained i and yields a precipitate on the addition of a silver, and more fully by acetate of lead.

Fibrin, or the *fibrous part of the blood*, is from the muscles of animals, or by agitation a ing of clotted blood.

Urea is a yellow crystalline substance, of a smell and taste, obtained from urine.

Saccharine Matter is formed in animal process

es are formed of cartilage, gelatine, and fat, de-
their hardness from the earthy salts which exist in
bundantly. These are phosphate and carbonate
;, and perhaps a small proportion of magnesia.
ls are formed of the salts of lime, deposited on ani-
atter disposed in lamellæ. In bones, the *phosphate*
s is most abundant; but in shells, the carbonate of
revails.
Muscles, or *flesh* of animals, contain albumen, ge-
and extractive matter, but are chiefly composed
n.
Skin is divisible into the *cuticle*, *epidermis* or *scarf-*
nd the *cutis* or *true skin*. The former appears to
chiefly of coagulated albumen, and the latter of
e; hence, it may be observed, that it is this part
hich the jelly is obtained.
maceti is found in the head of the sperma-
ale; whilst from its blubber is obtained *train oil*.
of some animals, as of the ox and sheep, becomes
substance, whilst that of hogs is much softer.
row, which is contained in the long bones of ani-
s an animal fixed oil, of peculiar properties, some-
esembling butter.
, exists in the different forms of *down*, *wool*, and
.
hers appear much to resemble hair in their com-
parts. The *quill*, Mr. Hatchett has shown, is
formed of hardened albumen.
d separates, on standing, into *cruor* or *coagulum*,
e *serum* or fluid part. The *cruor* contains *fibrin*,
s manifested in a white, solid, and elastic form,
hing the clot: and *the colouring matter* of the
which was long supposed to be iron, but is of an
nature. The *serum* is a fluid of a greenish yellow,
coagulates at 156°, and is divisible into *albumen*
osity. The blood contains water, fibrin, albumen,
e acid, hydrosulphuret of ammonia, soda, sub-
ate of iron, muriate of soda, phosphate of soda
lime.
secreted by the liver of animals into the gall-
, is of a dark yellowish green colour, of an unc
sel, a peculiar smell, and a bitter taste. It con-

tains a resin, and a substance peculiar to
piscumel, a whitish solid substance formed
with water and salts, chiefly phosphate of
sulphate, and phosphate of soda.

Definition 1.—When one chemical
pares another, it is called a chemical *test*."

2.—If salt be mixed in water, it is said to
tion, and the water is called the *menstruum*.

3.—If no more salt will dissolve, the
be *saturated*.

4.—If we would extract the salt, we
the water by *heat*, with a still, or retort,
if the *vapour* from either of these pass
tube or *worm*, to the *receiver*, we
water, and the *residuum* of salt will

5.—Solid substances are reduced into
turation, *pulverization*, and *levigation*
are pulverized by means of hammers,
tars, stones and mullers.

6.—The separation of the finer parts
the coarser is performed by means of

7.—*Filtration* is a finer species of
through the pores of paper, flannel,
It is used only for separating fluids from

8.—*Fusion*, or the melting of a solid body,
of heat, requires, according to their
cibles of different kinds strong enough to
made of earthenware, porcelain, or a
and powder of black lead, or of black-lead

9.—Sometimes crucibles have covers
ware, but in other cases the fused metal
to a current of air; for this purpose the
broad and shallow, and are called *cupels*.

10.—*Blow-pipes* are used for directing the
candle or lamp against any piece of ore or
required to be examined; and when the
pipes are used instead of common air, the
powerful.

11. The various degrees of heat which
for the performance of chemical operations,
necessary that the chemist should also be
with,—See *Grammar of Philosophy*.

Bones are formed of cartilage, gelatine, and fat, deriving their hardness from the earthy salts which exist in them abundantly. These are phosphate and carbonate of lime, and perhaps a small proportion of magnesia.

Shells are formed of the salts of lime, deposited on animal matter disposed in lamellæ. In bones, the *phosphate of lime* is most abundant; but in shells, the carbonate of lime prevails.

The *Muscles*, or *flesh* of animals, contain albumen, gelatine, and extractive matter, but are chiefly composed of fibrin.

The *Skin* is divisible into the *cuticle*, *epidermis* or *scarf-skin*, and the *cutis* or *true skin*. The former appears to consist chiefly of coagulated albumen, and the latter of gelatine; hence, it may be observed, that it is this part from which the jelly is obtained.

Spermaceti is found in the head of the spermaceti whale; whilst from its blubber is obtained *train oil*. The *fat* of some animals, as of the ox and sheep, becomes a hard substance, whilst that of hogs is much softer.

Marrow, which is contained in the long bones of animals, is an animal fixed oil, of peculiar properties, somewhat resembling butter.

Hair, exists in the different forms of *down*, *wool*, and *bristles*.

Feathers appear much to resemble hair in their component parts. The *quill*, Mr. Hatchett has shown, is chiefly formed of hardened albumen.

Blood separates, on standing, into *cruor* or *coagulum*, and the *serum* or fluid part. The *cruor* contains *fibrin*, which is manifested in a white, solid, and elastic form, by washing the clot; and *the colouring matter* of the blood, which was long supposed to be iron, but is of an animal nature. The *serum* is a fluid of a greenish yellow, which coagulates at 156°, and is divisible into *albumen* and *serosity*. The blood contains water, fibrin, albumen, benzoic acid, hydrosulphuret of ammonia, soda, subphosphate of iron, muriate of soda, phosphate of soda and of lime.

Bile, secreted by the liver of animals into the gall-bladder, is of a dark yellowish green colour, of an unctuous feel, a peculiar smell, and a bitter taste. It con-

...a resin, and a substance peculiar to bile, named ...*ermel*, a whitish solid substance formed into globules, ...th water and salts, chiefly phosphate of lime, muriate, ...ulphate, and phosphate of soda.

Definition 1. When one chemical substance decom... ...es another, it is called a chemical *test*.

2. If salt be mixed in water, it is said to be in *solu*...*tion*, and the water is called the *menstruum*.

3. If no more salt will dissolve, the water is said to be *saturated*.

4.—If we would extract the salt, we must *evaporate* the water by *heat*, with a still, or retort, or alembic; and if the *vapour* from either of these pass through a spiral tube or *worm*, to the *receiver*, we shall have *distilled* water; and the *residuum* of salt will remain in the *still*.

5.—Solid substances are reduced into powders by *tri*...*turation*, *pulverization*, and *levigation*; brittle substances are pulverized by means of hammers, pestles and mortars, stones and mullers.

6.—The separation of the finer parts of bodies from the coarser is performed by means of *sifting* or *washing*.

7. *Filtration* is a finer species of sifting, performed through the pores of paper, flannel, fine linen, sand, &c. It is used only for separating fluids from solids.

8. *Fusion*, or the melting of a solid body, by the act... of heat, requires, according to their several natures, ...*cibles* of different kinds strong enough to resist the ... made of earthenware, porcelain, or a mixture of ... and powder of black lead, or of black-lead altogether.

9. Sometimes crucibles have covers made of earthenware, but in other cases the fused metal must be exp... to a current of air; for this purpose the crucible ... broad and shallow, and are called *cupels*.

10. *Blow pipes* are used for directing the flame ... candle or lamp against any piece of ore or other sub... required to be examined; and when the inflam... cases are used instead of common air, the heat ... powerful.

11. The various degrees of heat which are ... for the performance of chemical operations, tend... cessary that the chemist should also be possessed ... ...ner.—See *Grammar of Philosophy*.

XXII. *Electricity and Galvanism.*

534. If *a* piece of glass, or sealing-wax, be ibbed on a piece of dry woollen cloth, or silk, id instantly held over any light substances, ey will be attracted towards it, raised on an id, and otherwise put in motion.

The power thus excited is called *electric;* id if the experiment be made in the dark, the *lass* and the *wax* will exhibit faint signs of *ht;* which light is called the electric fire or id.

535. If the glass be of larger dimensions, and rned rapidly round by a winch and a wheel, stead of being rubbed backward and forward ith the hand, and be provided with a piece silk to rub against it during its rotation, reams and large sparks of fluid fire will be icited, which will fly round the glass, attract ght bodies, and produce a pungent sensation.

Obs. 1.—By attracting light bodies, it is meant, that ht bodies move towards the electrified body; but it is be presumed, that that which is called attraction, is in ith some impulse from without or beyond the light dy. The mechanical action of attraction supposed to ist between distant bodies, seems to be an absurdity, id ought to be expunged from science. The term repul- n is even more absurd than attraction.

2.—Sir Richard Phillips in his Essays, page 92, pro- oses to substitute for the active verbs *attract* and *repel*, e passive ones *accide* and *discede;* and their nouns *accis n* and *discession*, as implying the mere facts of going to- ther and separating.

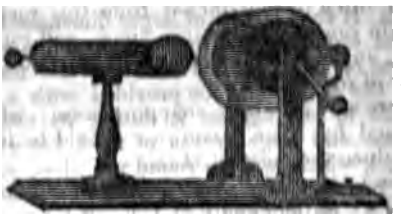
536. This glass, its cushion of silk, wheel, c. are called an electrical machine. The fluid,

or power produced by it, is one of the mo
wonderful in nature.

It is found, that it will pass along some o
dies, and not along others; that it may be
ceived and diffused by sharp points; that
superabundance of it, in one place, acts as
repellant in the parts immediately adjoining
and that it has a constant and violent tenden
to restore its own equilibrium in all bodies

THE ELECTRICAL MACHINE.

Prime Conductor. *Glass Cylinder*



537. The bodies, over which it passes freel
are all animals, most animal and vegetable su
stances, water, &c.; all which are called *co
ductors* of electricity.

But it will not pass over glass, sulphur, chi
coal, silk, baked woods, or dry woollen su
stances; nor through air, except by force,
sparks, to short distances.

All these bodies, therefore, are called *no
conductors*.

538. The power of exciting it, receiving it
points, and confining it to bodies, over whi

it freely passes, by placing these on bodies, over which it will *not* pass, gives rise to all the phenomena of practical electricity.

Hence a metallic *conductor*, provided with brass-points, and elevated on glass-legs, is placed opposite the revolving glass-cylinder, to receive by its points the electric power, which is condensed on the cylinder, but unable to escape on account of its being surrounded only by air, and supported by glass legs, both which are *non-conductors*.

539. If the hand, or a metallic knob, be held within three or four inches from this metallic or main *conductor*, a large spark will escape, which, in the dark, will be forked, and of the colour of *lightning*.

There will also be a snapping noise; which, increased by large quantities, would be likely to produce the noise of *thunder*.

In fact, *lightning* and *thunder* are effects of electricity in the clouds.

A flash of lightning is simply a stream of the electric power passing from the clouds to the earth; from the earth to the clouds; or from one cloud to another cloud; and *thunder* is the report, and the echoes of the report, between the clouds and the earth.

540. But the most wonderful effect of the electric fluid, is its power of suddenly contracting the muscles of animals when it violently passes through them from one place to another, to restore its equilibrium.

It will not pass through glass; if, therefore,

a plate of glass, in the form of a jar, or other wise, be coated on both sides, with either gold silver, or tin-foil, and one side be brought in contact with the main conductor, the other side will instantly part with its electricity, and the plate of glass be said to be charged.

541. If one hand be put to the under or outside of the said charged plate, and the other hand be brought into contact with the other or charged side, the equilibrium of the two sides will be restored through the body; and a violent contraction, or blow of the muscles will be felt, producing a shock peculiar to the operation.

The severity of the shock, is proportioned to the size of the plate or jar. When many jars are joined together, and charged in the way, they are called a battery; and some batteries have been made so powerful, as to kill an ox, melt gold, and produce all the surprising phenomena of real lightning.

542. Philosophers amused themselves, for a century, with experiments on the electrical apparatus; but a new mode of exciting the power, was discovered by *Galvani*; and the experiments made in his way, are called *Galvanism*.

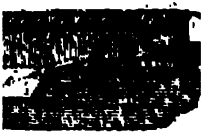
It is found, that there are two classes of conductors:—*perfect*, as the metals; and *imperfect*, as water and the mineral acids; and if they are laid alternately, two perfect and one imperfect, or two imperfect and one perfect, the two ends or sides, will constantly produce an electric *shock*.

stead, therefore, of the glass-cylinder, con-
ser, coated jar, &c., used in electrical ex-
ments, the *Galvanic pile*, or trough, is now
ployed.

The common exhibition of electrical effects, is
attractions and repulsions, in which masses of matter
concerned; but there are other effects, in which, the
es that take place, operate, in a manner, in small
s of time imperceptibly; and in which, the effects
roduced upon the chemical arrangements of bodies.
a piece of zinc and a piece of copper be brought in
ct with each other, they will form a weak electrical
mbination, of which, the zinc will be positive, the
per, negative: this may be learnt by the use of a de-
ensing electrometer; or by pouring zinc-fil-
through holes, in a plate of copper, upon a common
ometer; but the power of the combination may be
distinctly exhibited, in the experiments, called *Gal-
experiments*: by connecting the two metals, which
be in contact with each other, with a nerve and
e in the limb of an animal recently deprived of
; a frog, for instance; at the moment the contact is
ade, or the circuit made, one metal touching the
, the other the nerve, violent contractions of the
will be occasioned.

3. The Galvanic apparatus consists of a nar-
trough of earthenware, with grooves at cer-
distances, into which are slid alternately,
s of zinc and copper; and between each
ion, is poured a mixture of acid and water.
one hand be put to the plate of *copper* at
end of the trough, and another be put to
late of *zinc* at the other end, a smart shock
be felt, and will be continued for a great
h of time.

A GALVANIC TROUGH.



Obs. 1.—The above represents an earthen ware t
with its plates of separation, consisting, alternat
copper and zinc. A wire is fixed to each end, t
purpose of conveying the stroke to the flat plate,
any other desired purpose.

2.—The most powerful combination that exi
which number of alternations is combined with ea
surface, is that constructed by the subscriptions of
zealous cultivators and patrons of science, in the
ratory of the *Royal Institution*. It consists of tw
dred instruments, connected together in regular
each composed of ten double plates, arranged in c
porcelain, and containing in each plate thirty-two
inches; so that the whole number of double pl
2,000; and the whole surface 128,000 square i
This battery, when the cells were filled with 60 p
water mixed with one part of nitric acid, and one
of sulphuric acid, afforded a series of brilliant a
pressive effects. When pieces of charcoal, about
long and one-sixth of an inch in diameter, were b
near each other (within the thirtieth or fortieth p
an inch,) a bright spark was produced, and more
half the volume of the charcoal became ignited to
ness; and, by withdrawing the points from each o
constant discharge took place through the heated
a space equal at least to four inches, producing a
brilliant ascending arch of light, broad and conj
form in the middle. When any substance was intro
into this arch, it instantly became ignited; p
melted as readily in it as wax in the flame of a co
candle; quartz, the sapphire, magnesia, lime, all
into fusion; fragments of diamond, and points of

and plumbago, rapidly disappeared, and seemed to
[illegible] Such are the decomposing powers of
[illegible], that not even insoluble compounds are capa-
[illegible] resisting their energy; for even glass, sulphate
[illegible], fluor spar, &c., when moistened and placed
[illegible]ntact with electrified surfaces from the Galvanic ap-
[illegible]us, are slowly acted upon, and the alkaline, earthy
[illegible]d matter, carried to the poles in the common order
[illegible]ven the most solid aggregates, nor the firmest com-
[illegible]s, are capable of resisting this mode of attack; its
[illegible]ion is slow, but the results are certain; and sooner
[illegible]er, by means of it, bodies are resolved into simpler
of matter.—DAVY.

4. It is ascertained, that during these shocks
[illegible]ydation of the metallic plates takes place;
after their surfaces become tarnished, the
[illegible]k diminishes; but, on being wiped, its force
[illegible]newed.

[illegible] combination of these troughs forms a *gal-*
[illegible]*battery*, the force of which has produced
most surprising effects; and, by disturbing
[illegible]lose affinity of the constituent parts of many
[illegible]s, has led to the analysis of substances,
[illegible]sto deemed simple and elementary.

[illegible]—some fishes, as the torpedo, the gymnotus elec-
[illegible]and the silurus electricus, when touched, commu-
[illegible] shocks to the human body like those of electri-
but as there is no circuit for the fluid, in these
[illegible] no adequate solution has yet been found of this
[illegible] phenomenon.

3. Since the identity of lightning and elec-
[illegible]matter has been ascertained, philosophers
[illegible] been led to seek the explication of aërial
[illegible]ena in principles of electricity: and there
[illegible] doubt, th[illegible] the greater part of them, and
[illegible]ially the [illegible]ora borealis, are electrical, or
[illegible]us pheno[illegible]

It has been observed, that the aurora borealis produces a very sensible fluctuation in the magnetic needle; and that the flashes have been attended with various rumbling and hissing sounds.

Now black, and deep, the night begins to fall,
Dear to the state of the benighted wretch,
Who then, bewilder'd, wanders through the dark,
Perhaps, impatient as he stumbles on,
Struck from the root of slimy rushes, blue,
The wildfire scatters round, or gather'd, trails
A length of flame deceitful o'er the moss:
Whither, decoy'd by the fantastic blaze,
Now lost, and now renew'd, he sinks absorpt,
Rider and horse, amid the miry gulf:
At other times, gleaming on the horse's mane,
The meteor sits; and shows the narrow path,
That winding, leads through pits of death; or else,
Instructs him how to take the dangerous ford.

THOMSON.

518 Earthquakes, the most dreadful phenomena of nature, have been ascribed, by some naturalists, to water, fire, steam, and electricity, each of these powerful agents being supposed to operate in the bowels of the earth.

Subterraneous fire, and steam generated from it, are supposed to be the true causes of earthquakes. The elasticity of steam, and its expansive force, are every way capable of producing the stupendous effects attributed to earthquakes, the force of steam being 28 times greater than that of gunpowder.

Can the poor, brittle tenements of man
Withstand the dread convulsion? Their dear homes,
(With shaking, tottering, crashing, bursting, fall,)
The boldest fly; and, on the open plain,
Appall'd, in agony, the moment wait,
When, with disrupture vast, the waving earth
Shall whelm them in her sea disparging womb.

less affrighted, are the bestial kind:—
bold steed quivers in each panting vein,
staggers, bath'd in deluges of sweat;—
lowing herds forsake their grassy food
send forth frighted, woful, hollow sounds:—
dog, the trusty centinel of night,
erts his post assign'd, and piteous howls.

THOMSON.

7. The most remarkable changes in the and constitution of the earth, since the e, have probably been produced by sub-neous fires in volcanoes, and by earthquakes; hich plains are converted into mountains, cean into islands, and dry land into pools.

.—Half a pound of steel-filings, half a pound of lone, and a pint of water, will, when well mixed, e heat enough to make the mass take fire: and it ars, that volcanic mountains abound in such mix-; which are ignited, no doubt, by rain falling into craters, or by the sea communicating with their and lower cavities.

The fluid lake that works below,
umen, sulphur, salt, and iron-scum,
ves up its boiling tide. The lab'ring mount
orn with agonizing throes. At once,
th from its side, disparted, blazing pours
ighty river; burning in prone waves,
t glimmer thro' the night, to yonder plain.
ided there, a hundred torrent-streams,
h ploughing up its bed, roll dreadful on,
listless. Villages, and woods, and rocks,
l flat, before their sweep. MALLET.

8. The eruptions of volcanoes exhibit dread-phenomena, in prodigious inundations of d fire, which bear inevitable destruction them.

ie name of *lava* is given to these fiery ms, consisting of a mixture of stones, sand,

earth, metallic substances, salt, &c., calcined and vitrified.

The last great eruption of Etna, was in 1669; and the progress of the lava was at the rate of a furlong a day: it destroyed, in forty days, the habitations of 27,000 persons; and of 20,000 inhabitants of the city of Catanea, only 3,000 escaped.

The other great volcanoes in Europe are, *Vesuvius*, and *Hecla*; but there are two or three hundred in different parts of the world.

XXIII. *Magnetism.*

549. The power of certain ores of iron to attract pieces of iron, was known by the Greeks; but accident led an Italian to discover, that if suspended on a centre, and allowed to turn in any direction, one end would constantly point northward, and, of course, the other southward.

This ore of iron was called loadstone; and it soon became evident, that the property of distinguishing the north and south, was of the highest utility to ships at sea.

550. In the course of time, it was discovered, that *loadstone* communicated its property of turning northward to all pieces of iron and steel; and that these could communicate it to others, in a degree of strength proportioned to the number of magnets employed in transferring the property.

Natural magnets are not therefore now used; but needles are first made of the most convenient

ıe magnetic property communicated
:onnect with other natural, or arti-
ıs.

two poles or points of the magnetic
different properties, the south
nets attracting the north poles of
the same poles acting repulsively
ı other; i. e. a north pole repels a
nd a south, a south pole.

ıeat destroys the *polarity*; and so
ıf the hammer. But it will be se-
on-bars that long stand upright, or
ed red-hot, and left to cool in a po-

nagnet be laid on white paper, and
ıst be suffered to fall gently upon
will arrange itself on the paper in
:s, under the influence of the mag-
on.

netic bar be bent round into the
se-shoe, its poles in that position
ıd operate in a higher degree than
eparately; and the strength of all
increased by thus keeping their
ion.

ıets do not point exactly north and
ı different parts of the world, with
clination eastward or westward of
nd different in each place, at dif-

, at this time, the needle points 26
west of the north; or, rather more
north-north-west; and the incli-

nation has increased to the west from due for the years past.

Nor does the needle lie parallel, or flat, plane; but the north point is turned upw downward, and in London at this time i 72 degrees.

Obs. —The cause of the phenomenon of magnet hitherto, baffled the investigations of philosophe the more we think of them, the greater becomes barrassment; but some accidental discovery wi more than all reasoning; and till that occur, we content to class this, among the many unsolv wonders of nature.

XXIV. *Mathematics.*

554. Mathematics, or the mathematic ences, are divided into—

1. *Pure* mathematics; containing arit and geometry, which treat only of numb magnitude.

2. *Mixed* mathematics; which treat properties of quantity applied to nat astronomy, geography, &c.

3. *Speculative* mathematics; which c plate the proportions, relations, &c. of b

4. *Practical* mathematics; or their a tion to the practical uses of life.

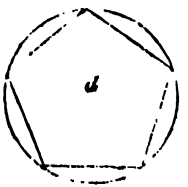
555. Geometry is an ancient, perfec beautiful science; which enables us to mine the relations and proportions of supe and solids.

Superficies consist of figures of *three* called triangles; of *four* sides, called qu

es, squares, parallelograms, and trapeziums;
five sides, called pentagons; of *six* sides,
lled hexagons; and of *many* sides, called
lygons.

Superficies also are circles, ovals, or ellipses;
ctors of circles, or parts cut out from the cen-
; and segments of circles, cut off by a strait
e, called a chord

A PENTAGON.



The above cut represents a *Pentagon* or *Polygon* of
e sides, inscribed within a circle.

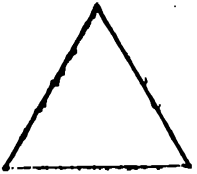
556. Solids are cubes regular and irregular;
pheres; cylinders; cones; pyramids; and
pheroids, or elliptical spheres.

A Cone cut obliquely to the base, forms an
llipsis; perpendicularly through the side, an
yperbola; and parallel to the side, a *parabola.*

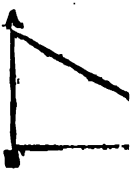
Angles are the corners, formed by the meet-
g of two lines.

A *right* angle is, when the lines are perpen-
icular to each other; an acute angle is less
an a right angle; and an obtuse angle is
reater than a right angle.

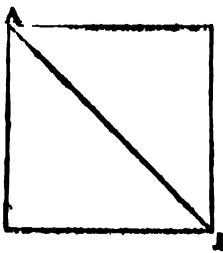
EQUI-LATERAL TRIANGLE.



RIGHT-TRI



SQUARE, AND DIAGONAL A B. AN



557. Parallel lines are those, whic distant; diagonals are those which c from one angle to another.

Tangents are lines that only touc in one point.

Every circle is equal to 360 de three angles of every triangle, are e degrees; the angles of every quadr equal to 360 degrees.

558. By means of a scale and a pa *pasues*, all kinds of figures may be rep

Triangles contain six parts; viz. three angles, nd three sides, and any one of the one and wo of the other being given, the other three nay be found either by projection, or by logaithms.

This art is called *trigonometry*: and by eans of it are performed most problems in stronomy, geography, navigation, and surcying.

It is founded on the great principle—that *all riangles which have equal angles, have all their ides in equal proportion*. This is the foundaion of tables for calculating triangles.

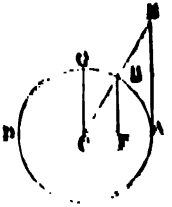
559. In every triangle, the three angles toether contain 180 degrees; and as a right anle is 90 degrees, the other two angles are, of ourse, equal to 90 degrees; all triangles may e reduced to right-angled triangles.

Tables, then, are calculated from the proortions of triangles; whose *base* or *hypohenuse* is 1,000,000,000, for every degree and inute of the acute angles.

Hence, if the base of a triangle be 67 yards, nd the angle 30 degrees, I can, in a moment, scertain the length of the other sides, by making a rule of proportion from the tables.

Obs.—In these tables, it should be understood, that the *ypothenuse* corresponds to the *radius* of 1,000,000,000; hat the *base* corresponds to the *co-sine*; and the *perpendicular* to the *sine*. Or, when the *base* is deemed the *radius*, the *perpendicular* is the *tangent*, and the *hypothenuse* he *secant*.

The elements of trigonometrical tables may, in a moment, be understood by attending to the following diagram:



D A is the *diameter*; C Q is the *radius*; also C F is the *co-sine*. Or, C A is the *radius*, the *tangent*; C N is the *secant*.

Tables, then, are calculated for these several every degree and minute of the quadrant for and as the sides of all triangles, which have eq are in exact proportion, it is evident, that we to adapt these already calculated proportion triangles; and the latter may be calculated by rule of proportion.

500. Superficial contents are ascert multiplying the length by the breadth solid contents, by multiplying the breadth, and depth, together.

Irregular superficial figures are to be to regular ones; and in solids, or such &c., a mean or average height or breadth certained.

Lines are in the proportion to each respective *lengths*; *superficies* in the p of their *squares*; and *solids* of their *c*

501. Every diameter of a circle is to cumference, as 1 to 3,14159.

The superficies of every circle is to t of its diameter, as 11 to 14, or as 0.7

The contents of every sphere is to the cube of its diameter, as 0.5236 to 1.

Every square foot contains 144 square inches.

Every cubic foot 1728 solid inches.

282 cubic inches are a gallon of ale; and 231, of wine.

562. The length of a pendulum vibrating seconds at London, is 39$\frac{1}{2}$ inches.

The English yard is 36 inches; the mile 1760 yards; and a degree of the earth's surface, 69$\frac{1}{35}$ miles nearly.

The French *metre* is the 10 millionth of the distance from the equator to the north pole; and is 39,371 inches English.

The English acre is 4,840 square yards; and 640 acres are a square mile.

The surveyor's chain is 100 links, 22 yards, 4 poles; and 10 square chains are an acre.

Note.—As the preceding numbers are the foundation of calculations relative to quantity, and are frequently called into use in real life, every young person should be expert in the recollection and use of them.

563. The tables in which all the properties of triangles are calculated, which have 1,000,000 for the radius are called tables of sines and tangents, and are to be found in various books of mathematics.

These numbers are reduced to logarithms for greater ease in making the proportions; addition in working logarithms, being a substitute for multiplication, and subtraction for division, and the process is finished in a moment.

Trigonometry also calculates the sides

of triangles, whose sides are parts of the circ
of the earth and heavens: hence, it is hig
useful to the astronomer and navigator. It
ables us to calculate the *heights* of buildin
and mountains, and the distance of celest
bodies.

The projection of spherical triangles as p
of the earth or heavens, and of maps on a
lular principle, is one of the most beauti
branches of practical geometry and astronom

555. *Logarithms* are numbers in arithmeti
progression; which, set with others in a
metrical progression, express their ratios
proportions to one another, as in the two f
lowing series, viz.,

Logarithms, 0. 1. 2. 3. 4. 5. 6. Arith. Pr
Numbers, 1. 2. 4. 8. 16. 32. 64. Geom. Pr

556. It is the peculiar and useful prope
of *Logarithms*, that for every *addition* and *s
traction* of one series, there corresponds to
in the other, a *multiplication* and *division*
the number to which they belong.

Thus, by adding 2 and 4 in the logarithm
series you have 6, which is the logarithm of
number in the lower series 64, the product
4 times 16; and the contrary for *division*.

By dividing a logarithm, you extract the r
of its number; so 6, the logarithm of 64,
vided by 2, gives 3, the logarithm of 8, wh
is the square root of 64; or divide 6 by 3
gives 2, the logarithm of 4, the cube root
64; and so of others.

Obs.— Having, therefore, completed a table of l

or all large numbers, the tedious labour of mul-
on, division, and extraction of roots, is saved by
tion, subtraction, and division of logarithms.

Perspective is that part of the mathema-
hich gives rules for delineating objects
lain superficies, just as they would ap-
the sight, if seen through a transparent
a pane of glass, or window.

ie representation of solid bodies, build-
:c., there are three divisions:—

nnography, which shews the plan or
-work of the building.

rthography, which exhibits the front or
a direct view.

cenography, which is the perspective
the whole building, fronts, sides, and
—See *Drawing*, &c.

.—Sciagraphy, or dialling, is the art of making
all kinds of planes; as horizontal, erect, or de-
or erect and reclining. The hour-lines, the
f the stile or gnomon above the plane, the dis-
the subtile from the meridian, and the differ-
longitude, are all calculated by spherical trigo-

a work like the present, correct general views
at can reasonably be expected; and the details
mmon sciences of reading and writing, grammar,
ic, and book-keeping, are supposed to be ac-
the routine of school-business, from such com-
ks as Blair's English Grammar, Joyce's Arith-
Morrison's Book-Keeping, and Nicholson's Ele-
ments of Mathematics.

XXV. *Algebra;*
OR,
Abstract Arithmetic.

508. If, in calculations, we were to substitute letters for known numbers, and operate with them by the signs +, −, ×, and ÷, till, by reasoning, we have acquired such a disposition of the said letters as expresses the result, and nothing but the result, we should simplify and shorten the calculation.

Such, then, is the science called Algebra. We adopt any letters of the alphabet at pleasure in place of any given numbers, and operate with them by the intervention of *signs* till we have the result.

Obs. For the sake of precision, it is usual to take the first letters for any known numbers, as a, b, c, d, &c.; and the unknown numbers from the last letters, as z, y, &c.

509. The algebraic signs are as follow:

\+ More or add, as $a+b$, is *a more* b, or *a added to* b.

− Less, as $a-b$, is *a less* by b.

× Multiplied; as $a \times b$, is *a multiplied* by b, or ab without the sign, is the same.

÷ Divided; as $a \div b$, is *a divided* by b; or $\frac{a}{b}$ is the same and more usual.

= Equal to; as $a=b$, is *a equal to* b.

:: As to; as thus, $a : b :: c : d$; that is, as a is to b, so is c to d.

^{2} Involved; as squared, cubed, &c.

$\sqrt{\ }$ Evolved; or the root extracted.

The root; as $\sqrt{a\,b}$, is the square root of $a\,b$. he power, as a^2 or b is the *square* of a or the ube of b; that is, $a \times a$, or $b \times b \times b$.

570. When an arithmetician wishes to pern his problem algebraically, he writes down e data of his question, as severally equal to a, b, or c, as he pleases; and the unknown or ught numbers, as x or y, or z; and then adds, ibtracts, multiplies, and divides these, by the gns, as his reason directs, till he arrives at a mple result.

Obs.—Suppose the joint ages of Eliza and Emily are , and that Eliza is three years older than Emily, and eir respective ages are required: put a then $= 23$ and $= 3$, and call Eliza's unknown age y, and Emily's z, d then algebraically it will stand.

$$a = y + z$$
$$b = y - z,$$

both, if these are added together, as $+z$ added to $-z$ estroys itself, it will then stand $a + b = 2y$; which, vided by 2, gives

$$\frac{a+b}{2} = y \text{ Eliza's age;}$$

d by restoring a and b, it will stand $\frac{23+3}{2} = y$, or $\frac{26}{2} = 13$, Eliza's age, and Emily's being 13—3 will, course, be 10.

9. A child, to whom the four first rules of arithmetic d the characters are known, may be made to under- and this; and I advise no female or young person to se it as a difficulty.—A course of Algebra may be dertaken, after a youth is master of vulgar and decimal actions.

571. Fluxions are the different magnitude or

increments, whereby any quantities, in
ing state, increase or decrease, according
ratio of the velocities.

Quantities and their fluxions are, (as in
bra) represented by letters; known quantiti
the first letters, *a*, *b*, *c*, *d*, &c.; and the *f*
by the last, as *v*, *x*, *y*, *z*; and their *fluxio*
the same with a point over them, as $\dot{v}$, $\dot{x}$

Obs.—As the ratios of velocities, in many ca
perpetually altering, as in the motion of falling
these fluxions vary every moment, and produce
of fluxions, or second fluxions, thus marked, $\ddot{v}$,
and the fluxions of these are third fluxions, as $\dddot{v}$,

XXVI. *Optics.*

572. This science is founded on the pro
of Light, which derives its chief source
the Sun, and is also generated or decom
by bodies in a state of combustion.

We ascertain the utility of light, by i
troduction of a candle or ray of sun shine
dark room. This, in an instant, renders
thing visible by the emission of innum
rays, or particles proceeding from the can
ray, to the objects, and from them to th
producing therein a figure of the objects
a corresponding sensation in the brain.

Fairest of beings! first created Light!
Prime cause of beauty! for, from thee alone
The sparkling gem, the vegetable rose,

ner worlds that live and breathe, their charms,
ely hues peculiar to each tribe,—
y unfading source of splendour, draw!
mire rays, with transport, I survey
nament, and those her rolling worlds;—
agnitudes and motions. MATTHEW.

Two hypotheses have been invented to account
incipal operations of light. In the first, it is
that the universe contains a highly rare elastic
which when put into a state of *undulation*,
those effects on our organs of sight, which con-
sensations of vision, and the other phænomena
by solar and terrestrial rays. In the second,
ived, that *particles* are *emitted*, or sent off, from
r heat-making bodies with great velocity, and
produce their effects by communicating their
o substances, or by entering into them, and
heir composition. The first of these suppositi-
adopted by Hook, Huygens, and Euler; the
Newton,—and the philosophers of the New-
ool. Most of the phænomena may be ac-
r, by either hypothesis; but the Newtonian
pplies more happily to some of the facts dis-
especting the modifications of light by double
and reflection.

By observing the regular eclipses of
moons in different parts of the earth's
is found, that rays, or vibrations of
vel twelve millions of miles in a mi-
t, they do not affect the eye in passing
and they could never be found to pro-
slightest impression on the most deli-
nce.

uires 12 rays or pulsations of light to
e eye in every second, to produce a
perception of the object, whence the
ulsations proceed.

Hence, rays or pulsations of light, in pass
from distant bodies to the eye, may be 10,
miles behind each other, and yet produce a
stant vision.

Obs.—The eclipses of Jupiter's moons are calcul
for a mean distance of the earth; but they happen so
or later, as the earth is nearer, or more distant from
piter. The number of rays necessary to produce vi
is ascertained, by turning a piece of burning wood
circle till the circle is wholly illuminated. The twi
ling of the stars, do ses from paucity of ra

574. Pulsati of ht pass freely thro
air, water, g s, t co s and humours of
eye, and other t nt mediums. At
back of the eye, a net of nerves, cal
the optic nerve; to eive their impressi
and communicate fect to the brain.

The rays pass through a small hole called
pupil, and form, on the optic nerve, a beaut
and perfect picture of the objects before
eye. A *camera obscura* acts on the princi
of the eye: and a common spectacle-glass
shew the same effect, held at a proper distan
from a wall.

575. But though effects of light pass in strai
lines through any medium when in it; they
turned out of their course, as they pass obliqu
out of one transparent body into another;
this effect is called *refraction*.

If a stone be thrown obliquely into water,
will be evident that when it strikes the wa
it will fall to the bottom in a direction more p
pendicular than before it came in contact w

the water. Such, too, is the effect of *refraction* on rays of light; which, on passing into water, or any heavier transparent body, are bent downward.

Obs.—To verify and understand this principle, put a halfpenny into an empty basin, and stand at such distance that the coin may not be visible; then, let another person pour pure water into the basin, and the halfpenny will become visible: this arises from the bending of the rays in their passage into air at the surface of the water.

576. Hence, when the rays of light coming from the celestial bodies, arrive at our atmosphere, they are bent downward; and those bodies appear, when in the horizon, ½a degree higher than they are.

Many rays of light are *reflected* at the surface of a new transparent medium, in an angle equal to that in which they fall on the surface, and on this principle all mirrors are constructed.

577. Advantage is taken by man of the property of refraction, to construct new mediums of such shape, as that all rays that fall on them may, on coming out of them, converge in one point instead of going straight forward.

The construction of surface which produces this effect is the convex; and all rays of light which fall on a circular surface of glass, &c., are converged on the other side into a series of corresponding points, representing the objects whence the light proceeded.

Such are spectacle-glasses, called *lenses*.

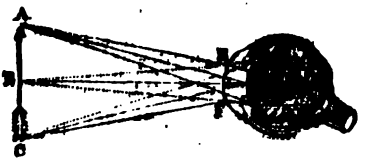
Obs.—Two or three lenses, of different degrees of convexity, may be purchased at any optician's for sixpence

each; and the various illustrative e[illegible]ents that m[illegible] be tried with them, render it desirable that they sho[illegible] be at hand, in every seminary of education.

578. The eye consists of a transparent hor[illegible] coat on its outside, called the *cornea*; with it, is a pure liquid c[illegible]h the *aqueous humour* and within the aqueo[illegible] humour, is a *lens*, like spectacle-glass, [illegible] *crystalline humour* yond that, [illegible] jelly-like humour, called t[illegible] v[illegible] [illegible] filling t[illegible]e ball of the eye; a[illegible] at [illegible] [illegible] of the eye, is spread the op[illegible] nerve, *ret[illegible]*, or fine net-work, to receive t[illegible] impressions of the rays of light.

The horny coat, the *lens*, called the crysta[illegible] line humour, and t[illegible] other transparent h[illegible] mours, answer the [illegible] purpose of one sp[illegible] tacle-glass, with a[illegible] and wonderful powers adaptation.

THE EYE



The *Circle* represents the ball of the eye; and the arr[illegible] A B C, any object to be seen by the eye. Rays proce[illegible] from all points of the arrow; but some of those fr[illegible] A B C only, are represented, to avoid confusion. Th[illegible] flow from A B C in straight lines as represented. Th[illegible] fall on the *cornea* at E F, pass through the *aqueous* h[illegible] mour to the *iris* or *pupil*; thence, through the convex l[illegible] or *crystalline humour*, shaded dark; and thence, thro[illegible]

ball of the eye, filled with the vitreous humour, reconverging and producing a perfect picture of the arrow at the back of the eye at *c*, *b*, *a*, where is spread the fine net-work, or retina of the *optic nerve*. The tube at the corner, is the optic nerve going to the *brain*:—such is the simple, but wonderful economy of vision!

Obs.—To comprehend the effect on the *lens* of the eye in producing vision in the different ways in which the rays may fall upon it, hold a spectacle-glass, by means of a rule or stick, at unequal distances from a wall; which wall may be supposed to represent the back of the eye. Then place a candle at such distance, or adapt the lens to that distance, and a beautiful picture of the candle reversed will be seen upon the wall. Keep the lens fixed, and move the candle nearer to it, and the image will be less distinct, and quite vanish, as it approaches; then carry the candle backward, to a greater distance than the first distance, and, in like manner, the image will again become indistinct. In the first instance, the rays fall with such a degree of obliquity, as, when operated upon by the refraction of the glass, occasions the whole of them to converge, and reproduce, in opposite and cross directions, an image of every part of the candle; but when carried nearer, the refracting power of the glass is unequal to the great degree of convergency required, and either the image will be produced at a greater distance, that is, beyond the wall, or the rays will go out parallel; or even diverge or spread, if the candle be carried till nearer. Hence, vision depends on the parallelism or obliquity of the rays proceeding from an object, and on the power of the eye to accommodate itself to that obliquity; and when that is greater than the power, art is necessary to diminish or increase the obliquity of the rays, so as to accommodate them to the powers of the eye. Aged people require spectacles to increase the convergency, because in these, all the humours diminish, and the chrystalline lens of the eye becomes flatter, and the cornea itself less convex: hence, the power of convergency is diminished, and the images of objects fall beyond or behind the optic nerves. This can be illustrated in a moment, by having two lenses of different convexities held at the same dis-

tance from the wall; and it will be proved, that when the more convex, or youthful lens, produces a distinct picture, the flatter, or aged one, produces a confused image.

579. The different distances, at which *lenses* produce on a wall the representation of objects, is called their *focal* distance; and it is the centre of the circle, of which the surface of the common double lens is a part.

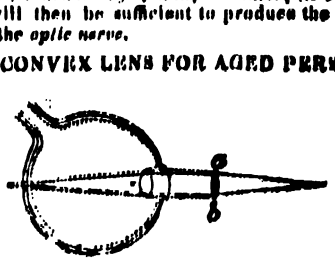
The *concave* lens has the opposite effect; it *diverges* or spreads the rays, instead of *converging* them to a focus.

Hence, when the *eye* is too flat in old age, the convex lens helps its converging powers.

And when it is too convex, as in short-sighted people, the concave lens counteracts the convexity of the eye, spreads the rays, and renders vision distinct.

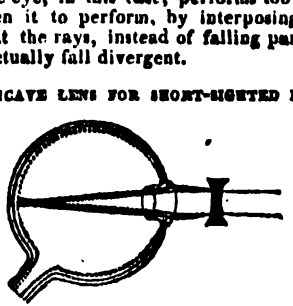
Obs. 1.—The next circle represents the ball of an aged eye; in which, owing to the decay of the humours, the cornea is not convex enough to converge the rays on the *retina*, but only a little beyond it. The object will, therefore, appear with a burr around it, or confused. If, then, a *convex lens* or spectacle-glass be interposed, as *a*, *b*, this will give a converging direction to the rays before they reach the eye; and, of course, its converging power will then be sufficient to produce the figure exactly on the *optic nerve*.

THE CONVEX LENS FOR AGED PERSONS.



—In this figure, the cornea is supposed to be
ea, as in short-sighted persons; and the rays
irged before they reach the back of the eye or
The eye, in this case, performs too much; and
iven it to perform, by interposing a concave
hat the rays, instead of falling parallel on the
actually fall divergent.

ONCAVE LENS FOR SHORT-SIGHTED PERSONS.



But besides the useful invention of spec-
arising from this power of converging
light in convex lenses, a very important
es from their combination in microscopes
escopes, the principle of which is ex-
ly simple.

y visible object is of a visible size, pro-
ed to the *angle* which it makes to the
ıd that angle is also always in the inverse
ion * of the distance, which the eye is
e object.

To prove this, try a simple microscope without
s, and it will enable you to see an object clearly
istance of an inch; which, with the naked eye,
t be well seen at less than eight inches; and the

term *inverse* signifies something like a *contrary*.
size is not as the distance; because, as the dis-
greater, the size is *less*; the proportion is, there-
direct, but opposite, contrary, or *inverse*.

object, suppose a grain of sand, will apparent
times larger in diameter, 64 times in surface
times larger in bulk! This simple microscope
more than a small hole pricked with a fi
through a piece of blacked card. The hole,
the number of rays from the object, will en
see the object as above, and prove that the siz
angle, or inversely as the distance. Every
length or breadth, is, in size, in the inverse pr
its distance; because the angle, which its si
to the eye, is of a size inversely proportione
tance. Thus, a man at 100 yards distant, is h
apparent height that he is at the distance of 50
only a tenth of his size at ten yards distan
magnified, therefore, ten times, by any contriv
enables us to view him under the same angle a
distant as we should see him with the nake
yards.

681 The object, then, of all arra
of glasses, or lens, in microscopes a
copes, is first to produce an image o
ject, and then to dispose of the rays p
or diverging from the image, in such
as that it may produce distinct visio
eye.

The sole use of the object-glass is
pose the rays anew, so that they may
vision by the approximation of an e
and the magnifying power will depen
closeness with which the eye glass en
eye to see the image produced by th
glass; or, on the convexity of the eye

Or, in other words, the magnifyi
will be in the ratio of the focal distan
object-glass to that of the eye-glass.

Obs. 1.—If a tree, at the distance of 400
tend an angle of one degree to the naked

image of it is produced by the object-glass of a telescope, and I am enabled by the convexity of an eye-glass to view that image so closely, as that the visual angle is increased to 40 degrees, the effect is the same as if I had advanced within 10 yards of the tree, when its angle would, to the naked eye, have been increased to 40 degrees. The tree is consequently magnified by the eye-glass 40 times in heighth and breadth.

2.—In a microscrope, as the object itself can be brought so near, as to serve the purpose of the image in the telescope, the single microscope is but one lens, but the compound microscope is an arrangement of eye-glasses; which, in some of them, enables the eye to view the image within the 50th part of an inch; thereby enlarging the object in comparison with the natural vision, at six inches distance, 300 times in length and breadth, or 9,000 times in surface.

THE TELESCOPE.

A D is the *Object-Glass*, or glass nearest the object.

E Y is the *eye*-glass.

K is the eye of the observer.

O B is the object or scene to be viewed.

O C B is the angle under which the remote object is seen by the naked eye.

I C M is the angle of the optical image produced by the object-glass, and is equal to the angle O C B, being produced by the crossing of the same lines.

The glass E Y enables the eye to see the image I M under the angle E K Y, which is the same as E P Y.

These angles are, however, in the inverse ratio of the distances E P and P G; or, in other words, as the focal distances of the object and eye-glasses, and such, therefore, is the power of the telescope generally.

In such a glass, the image will be reversed to the eye, but, by adding two other eye-glasses, it is set straight again. In *Gallilean*, however, only one eye-glass is need-

ful. In viewing the heavenly bodies, the reversal no consequence.

592. As the image is reversed by a single owing to the crossing of the rays in the c of the lens, the magnified image is reve when viewed with one eye-glass; two glasses are therefore added; one for the pur of restoring the image to its natural posi and the other for the urpose of viewing at first.

The lens within the eye, reverses objects the mind contemplates the top of the nerve, as corresponding with the bottom o object; and the mental effect, is the resu habit, or of *learning to see* in infancy, or the eyes have been couched in manhood.

593. Telescopes are *refractors*, when effect is produced solely by refraction thr transparent lenses; or *reflectors*, when the i is produced by the converging rays of a con mirror; but the principle of the magni power is the same in all.

They are called *Gallileos* when the eye is concave, after *Gallileo*, the inventor of scopes, who made all his discoveries in a nomy by a small telescope, which magnifie 19 times; whereas Herschel's great tele magnifies 6,000 times!

594. Of course, without light, the world be involved in total darkness; and without mechanism of eyes, and optic nerves to co the varied sensations of light to the brain the beauties of nature derived from its dif

f colouring, all the interesting relations of day nd night, and half the pleasures of existence, ould be totally lost.

The cause of the various colours which adorn ie creation is, of course, an object of interest-ig inquiry; this discovery was the greatest of ose made by Newton.

"The beams of light had been in vain display'd,
Had not the eye been fit for vision made
In vain, the Author had the eye prepar'd,
With so much skill, had not the light appear'd.

BLACKMORE.

585. Every one observes the beautiful colours roduced by the pendent drops of cut-glass anging to lustres and chandeliers, whether de-ved from candle-light or sunshine.

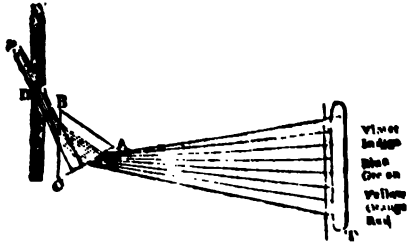
It is observed too, that drops of rain are co-ured in like manner, when the sun shines upon iem; and the regular form of the colours in ie rainbow, led Newton to conclude, that these olours, as well as colours in general, were pro-uced by some property in rays of light.

586. Newton made a beam of sunshine pass rough a hole in a window-shutter, and fall on glass prism or wedge, so as to be refracted st of its course towards the ground, and rown upwards on the opposite wall.

He then found, that the circular beam of light as rendered oblong, and regularly coloured; at the uppermost part, or the rays most re-acted, were *violet*, their next division *indigo*, e next *blue*, then *green*, *yellow*, *orange*, and, bottom, *red*, being the seven colours of the inbow.

Of parent-colours, first, the flaming *red*
Sprung vivid forth; the tawny *orange*, next;
And next, delicious *yellow*; by whose side
Fell the kind beams of all-refreshing *green*:
Then the pure *blue*, that swells autumnal skies,
Ethereal play'd; and then, of sadder hue
Emerg'd the deepen'd *indigo*, as when
The heavy skirted evening droops with frost;
While the last gleamings of refracted light
Dy'd, in the fainting *violet*, away. BLACKMO

THE PRISM AND ITS COLOURS.



R represents the shutter of a room.

D a hole in the shutter.

S rays of light proceeding from the sun passing thro the hole, and falling on the glass prism B A C; on m ing which at B C, instead of going straight on, it is fracted, and leaves the prism at A C.

T is its figure on the opposite wall, spread fro circle to an oblong, and presenting the colours of refracted rays in succession as marked.

587. A beam of *white* light is, therefo found to consist of rays of all the colours; an is evident, that the various colours of all bodies in nature, depend solely on the powe *the surfaces* to absorb some rays, and ref *others*.

It appears, too, that *white* is a due mixture of the seven primary colours wholly reflected; that *black* objects absorb all the rays, reflecting none; and that black is an effect of negation.

Colours are but the phantoms of the day;—
With that they're born, with that they fade away;
Like beauty's charms, they but amuse the sight,
Dark in themselves, till, by reflection bright,
With the sun's aid, to rival him they boast;
But light withdrawn, in their own shades they're lost.
HUGHES.

588. Hence, white bodies in the sun are cool, and black ones hot; because white surfaces reflect all the light, and black ones absorb it; hence also, as red rays are the least refracted, they are supposed to be the largest, and are therefore painful to the eye; and hence, the most refrangible rays, as the smallest, are the most grateful.

Obs.—When similar thermometers are placed in the different parts of the solar beam, separated by the prism, it is found, that different effects are produced in the different coloured rays. The greatest heat is exhibited in the red rays; the least in the violet rays; and in a space beyond the red rays, where there is no visible light, the increase of temperature is greatest of all. This important discovery was made by Dr. Herschel. He estimates the power of heating in the red rays, to be to that of the green rays as 55 to 26; and to that of the violet rays as 55 to 16. A thermometer, in the full red rays, indicated an increase of temperature of 7°. Fahrenheit, in ten minutes; beyond the red rays, in an equal time, the increase was 9°. Fahrenheit. From these facts, it is evident, that matter set in motion by the sun, has the power of producing heat without light, and that its rays are less refrangible than the visible rays. Rays capable of producing heat, with and without light, proceed from bodies at the surface of the globe under peculiar agencies

or changes, as well as from the sun; and the phenomena, that are usually called the phenomena of the *radiation of terrestrial heat*, are of great extent and importance, and well worthy of being studied. There is another fact, still more extraordinary, which has been called *the radiation of cold*, first observed by the Italian philosophers, and afterwards by Pictet. If in the arrangement of the two parallel mirrors, a piece of ice be introduced into the lower focus, the thermometer in the upper focus will indicate a diminution of temperature.

589. Rainbows arise from the rays of the sun which fall on drops of water being reflected and refracted to the eye of the spectator; and, of course, all those drops which are situated at the *same angle all round* from the eye, will present the same colour.

And, as different colours will arise at different angles; a bow composed of regular circles is a necessary consequence of showers of rain, while the sun shines.

It will, however, only be visible opposite to the sun; and the line from the sun through the eye of the spectator must be its centre.

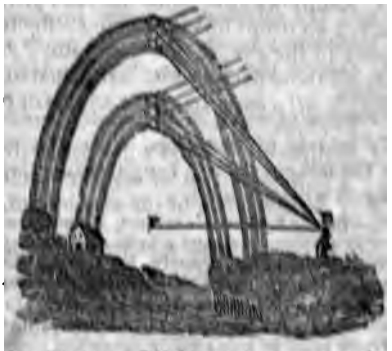
590. As rays will reach the eye from drops of rain, owing to two different causes; so there will generally be two rainbows, one fainter, however, than the other.

The strongest, or *lowermost* rainbow, is occasioned by the light being reflected from the upper part of the back of the drops of rain; and the other, or *upper* bow, is occasioned by the light being *twice* reflected within the drop from the lower part to the upper, and thence, *refracted* to the eye.

591. The breadth of a rainbow is about two

rees; and, of course, no two spectators can
the same rays; but every eye will be the
re of its own bow.
circles round th
manner, from the pe
rays passing thro
phere in peculiar

THE R



g. 1.—The rays of light are shewn as passing from
un to the drops of water, and thence to the eye of the
tator E; and all the rays at the same angle from the
se centre I³, necessarily produce the same colours.
g. 2.—The spectator stands, of course, with his back
e sun, and his eye is necessarily the centre of the
, each drop of the same colour having an equal an-
from the eye. Rainbows, of course, are more or less
l, as the sun shines more or less bright on the oppo-
rain; and they are more or less perfect, as the rain
are or less diffused. An artificial bow may be made
a fountain; —— glass chandeliers reflect colours on
ally the same principles.

Obs. 3.—In the inner Bow, the colours are red at top, then orange, yellow, green, blue, indigo, and violet; and, in the upper Bow, the contrary. The upper Bow makes an angle with the eye of 54° and 51°; and the lower, of 42° and 40°. The centre of the circle is a line passing from the Sun, through the eye of the spectator.

502. A *magic lanthorn* is founded on the principle of placing the image within the focus of the lens; so that the rays diverge and produce a figure as much larger as is desired on a wall; and [*Phantasmagoria* are produced by magic lanthorns; in which all the parts of the sliders, except the figures, are painted black and opake.

The *camera obscura*, for drawing landscapes, consists merely of one lens, with a mirror to reflect the images on the rough glass placed to draw upon with a pencil.

Obs. 1.—Before I leave this subject, I must recommend the tutor or student, to dissect a bullock's or sheep's eye. By taking off the back delicately, he will see the landscape before the eye beautifully painted on the optic nerve; he will find in front, the *cornea*; beneath it, the *aqueous humour*; then the *iris*; so called from its various colours; the *pupil* or hole; which opens and shuts to the light; and the *crystalline humour*, or *lens*. Then, the *vitreous humour*; and then, the *optic* nerve or *net-work*; —a curious and wonderful arrangement!

2.—The instantaneous motion of light has given rise to the TELEGRAPH, a modern invention of the greatest social importance, at present limited to purposes of governments; but capable of the highest uses to the community at large.

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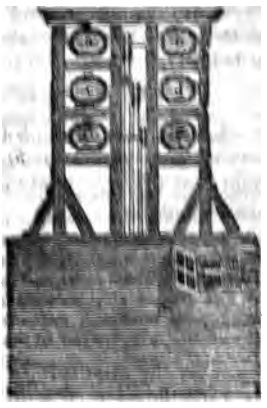
THE TELEGRAPH.



XXVII. *Meteorology.*

1. Every 100 parts of the atmosphere is
osed of 20 parts of oxygen, and 72 of
or nitrogen, kept in a gaseous state by
le or heat.
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tion to rain water, as 12 to 1000, and to oxygen gas, as 5 to 6; and to hydrogen, as 15 to 1; a cubit foot of it weighing 525 grains; or one ounce and a quarter, nearly.

594. The atmosphere is found to be very elastic; and, in consequence, to press on every side, equal to a weight of 33 feet of water, or 29½ inches of mercury; and this elasticity is found to decrease, as we ascend higher and higher, so as to render the barometer a means of ascertaining heights.

Obs. 1. This elasticity is equally powerful in a cubic inch of the atmosphere, as in the whole mass; and an inch will raise the mercury in the barometer, as much as the whole atmosphere. One cannot, therefore, but wonder at the quackery, or inconsiderateness of authors, who copy, one after another, the idle nonsense about the atmosphere pressing a man with a weight of 30,000 lbs., when, in fact, he is not pressed to the amount of an ounce, all the vesicles of his body being filled with air, which presses outward, at least as much as the atmosphere presses inward, and also upward as well as downward. In fact, in regard to animal and vegetable bodies, the slight gravity of the air is destroyed by its elasticity.

595. Comparing the atmosphere to fleeces of wool laid upon one another, it will be lighter and rarer as we ascend in it; or, in other words, its elasticity will be diminished.

Were it all of uniform density, like water, it would be about five miles high; but the reflection of the sun's rays appears to be affected by it at the height of 44 miles; where it is calculated to be 4,000 times less elastic than on the *surface* of the earth.

The blue colour of the atmosphere is now

olour. Its power of reflection produces ersal diffusion of light.

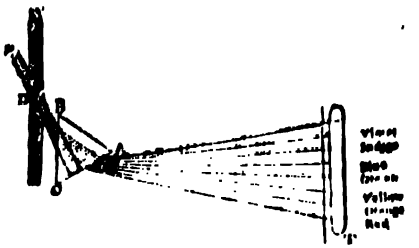
On the elasticity of air, is founded the invention ring bells; by means of which, an operator de any depth in water, and remain there for hours.

Weights are placed at the bottom to prevent it ing; and a forcing pipe sends in fresh air, to e waste of air from the respiration of the

THE DIVING BELL.

Of parent-colours, first, the flaming *red*
Sprung vivid forth; the tawny *orange*, next;
And next, delicious *yellow*; by whose side
Fell the kind beams of all-refreshing *green*:
Then the pure *blue*, that swells autumnal skies,
Ethereal play'd; and then, of sadder hue
Emerg'd the deepen'd *indigo*, as when
The heavy skirted evening droops with frost;
While the last gleamings of refracted light
Dy'd, in the fainting *violet*, away. THOMSON

THE PRISM AND ITS COLOURS.



E represents the shutter of a room.

D a hole in the shutter.

S rays of light proceeding from the sun passing through the hole, and falling on the glass prism B A C; on meeting which at B C, instead of going straight on, it is refracted, and leaves the prism at A C.

T is its figure on the opposite wall, spread from a circle to an oblong, and presenting the colours of the refracted rays in succession as marked.

587. A beam of *white* light is, therefore, found to consist of rays of all the colours; and it is evident, that the various colours of all the bodies in nature, depend solely on the power of the surfaces to absorb some rays, and reflect others.

It appears, too, that *white* is a due mixture of the seven primary colours wholly reflected; that *black* objects absorb all the rays, reflecting none; and that black is an effect of negation.

Colours are but the phantoms of the day;—
With that they're born, with that they fade away;
Like beauty's charms, they but amuse the sight,
Dark in themselves, till, by reflection bright,
With the sun's aid, to rival him they boast;
But light withdrawn, in their own shades they're lost.
HUGHES.

588. Hence, white bodies in the sun are cool, and black ones hot; because white surfaces reflect all the light, and black ones absorb it: hence also, as red rays are the least refracted, they are supposed to be the largest, and are therefore painful to the eye; and hence, the most refrangible rays, as the smallest, are the most grateful.

Obs.—When similar thermometers are placed in the different parts of the solar beam, separated by the prism, it is found, that different effects are produced in the different coloured rays. The greatest heat is exhibited in the red rays; the least in the violet rays; and in a space beyond the red rays, where there is no visible light, the increase of temperature is greatest of all. This important discovery was made by Dr. Herschel. He estimates the power of heating in the red rays, to be to that of the green rays as 55 to 26; and to that of the violet rays as 55 to 16. A thermometer, in the full red rays, indicated an increase of temperature of 7°. Fahrenheit, in ten minutes; beyond the red rays, in an equal time, the increase was 9°. Fahrenheit. From these facts, it is evident, that matter set in motion by the sun, has the power of producing heat without light, and that its rays are less refrangible than the visible rays. Rays capable of producing heat, with and without light, proceed from bodies at the surface of the globe under peculiar agencies

or changes, as well as from the sun; and the phæn
that are usually called the phenomena of the radi
terrestrial heat, are of great extent and importance
well worthy of being studied. There is another
still more extraordinary, which has been called
diation of cold, first observed by the Italian philoso
and afterwards by Pictet. If in the arrangement
two parallel mirrors, a piece of ice be introduce
the lower focus, the thermometer in the upper foc
indicate a diminution of temperature.

869. Rainbows arise from the rays of th
which fall on drops of water being reflecte
refracted to the eye of the spectator; an
course, all those drops which are situated
same angle all round from the eye, will p
the same colour.

And, as different colours will arise at dif
angles; a bow composed of regular circle
necessary consequence of showers of rain,
the sun shines.

It will, however, only be visible oppos
the sun; and the line from the sun throug
eye of the spectator must be its centre.

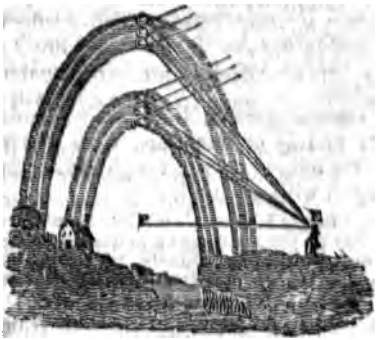
870. As rays will reach the eye from
of rain, owing to two different causes; so
will generally be two rainbows, one fainter,
ever, than the other.

The strongest, or *lowermost* rainbow, i
occasioned by the light being reflected fro
upper part of the back of the drops of
and the other, or *upper* bow, is occasione
the light being *twice* reflected within the
from the lower part to the upper, and th
refracted to the eye.

871. The breadth of a rainbow is about

tes; and, of course, no two spectators can
be same rays; but every eye will be the
e of its own bow.
l circles round the sun and moon arise in
manner, from the peculiar modifications of
ays passing through the vapours of the at-
here in peculiar states.

THE RAINBOW.



. 1.—The rays of light are shewn as passing from
n to the drops of water, and thence to the eye of the
tor E; and all the rays at the same angle from the
centre P, necessarily produce the same colours.
. 2.—The spectator stands, of course, with his back
sun, and his eye is necessarily the centre of the
each drop of the same colour having an equal an-
om the eye. Rainbows, of course, are more or less
as the sun shines more or less bright on the oppo-
ain; and they are more or less perfect, as the rain
e or less diffused. An artificial bow may be made
a fountain; and glass chandeliers reflect colours on
ly the same principles.

Obs. 3.—In the inner Bow, the colours are red at top, then orange, yellow, green, blue, indigo, and violet; and, in the upper Bow, the contrary. The upper Bow makes an angle with the eye of 54° and 51°; and the lower, of 42° and 40°. The centre of the circle is a line passing from the Sun, through the eye of the spectator.

592. A *magic lanthorn* is founded on the principle of placing the image within the focus of the lens; so that the rays diverge and produce a figure as much larger as is desired on a wall; and *Phantasmagoria* are produced by magic lanthorns; in which all the parts of the sliders, except the figures, are painted black and opake.

The *camera obscura*, for drawing landscapes, consists merely of one lens, with a mirror to reflect the images on the rough glass placed to draw upon with a pencil.

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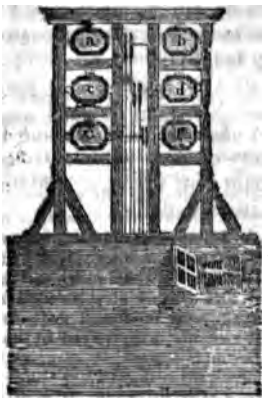

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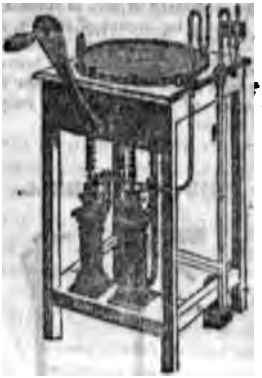
The blue colour of the atmosphere is its

colour. Its power [illegible] produces universal diffusion [illegible]

—On the elasticity of [illegible] invention Diving Bell; by me[illegible] operator de- to any depth in wate[illegible] here for hours [illegible]. Weights are plac[illegible] to prevent it [illegible]ing; and a forcing [illegible] in fresh air, to [illegible] the waste of air [illegible] respiration of the [illegible]er.

THE DIVING BELL.

THE AIR-PUMP.



596. By means of the air-pump, all may be drawn out of a large glass-vess vacuity or *vacuum* produced; in whicl number of curious experiments may formed, shewing at once the properties fulness of air.

The figure represents an air-pump on the be construction. The glass-receiver, as it is called at top; where there is a hole, to let out the action of the pistons seen below.

597. In the aerial vacuum, a feathe guinea will fall with equal velocity, there being no resistance of air.

If a bladder, apparently empty, be ti neck and left in it, the small quantity the bladder will swell it, and presently

A bell will cease to sound *in vacuo*.
The smoke of a candle, having no air to float will fall to the bottom by its own weight.
No animal will live, or any light burn, *in vacuo*.

Obs.—A bladder, tied in the same manner, will swell l burst, if laid before a fire; thereby proving the wer of heat to rarefy air.

598. Common air may also be compressed, by ld or by mechanical means, into forty thou- nd times its ordinary space, and still maintain elasticity; and on this principle is founded e invention of the air-gun. Air has a constant sposition to maintain its equilibrium, level, or ual diffusion, like water.

Hence, if a bladder, filled with rarefied air, rst, an explosion takes place, from the rush- g of the surrounding air to fill the space.

The same principle is the cause of all *wind*, ich may be traced to some local expansion or mpression of air by heat and cold; thus, also, oke is carried up chimneys.

Obs.—Is is evident, that the density of bodies must be ninished by expansion; and in the case of fluids and es, the parts of which are mobile, many important enomena depend upon this circumstance. If heat be plied to fluids or to gases, the heated parts change ir places and rise; and the colder parts descend and upy their places. Currents are constantly produced the ocean and in great bodies of water, in consequence this effect. The heated water rises to the surface in tropical climates, and flows towards colder ones; s the warmth of the Gulf-stream is felt a thousand les from its source, and deep currents pass from the der to the warmer parts of the sea: the general dency of these changes, is to equalize the temperature the globe.

599. One of the principal forces mixed with, or dissolved in the atmo the vapour of water which is conste at every degree of heat, provided th the vapour already in the atmosph greater than that of vapour at the ex perature.

By this perspiration of the globe, of water per annum are raised from t of all seas or rivers; and, at least, from all land.

In December and January, it is 1½ month; and in July and August, mo inches.

600. By this constant process of ev 100,000 cubic miles of water are, e raised into the atmosphere; the grea which, at a certain height, parts with and is condensed into clouds.

These are carried by the winds ove broken and precipitated by the actio trains and trees; and thus rendered th watering the soil.

It then returns to the sea in the rivers; so that there is a constant ch waters! They are chiefly raised fr are carried by the winds over the la rain; and then return again to the sea

The streams, their beds forsaking, upwar
And form again, in wand'ring clouds aboo
Hence, rich discerning showers; hence, h
Their plenteous sweets o'er brightning fie
Hence, cheats the grass; the garden smiles
And sportive gales steal fragrance from th

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quantity of rain which falls in Great
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the hills, forms springs.
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. Rain oozes down by the crannies of the
es, and enters the caverns of the hills.
hese being filled, the overplus water runs
by the lowest place, and breaking out by
ides of the hills, forms springs.
hese running down the vallies, between the
es of the hills, and uniting, form little rivu-
or brooks; and these, meeting in one com-

mon valley, become a river, which runs into sea,—the common level.

I see the rivers in their infant-beds!
Deep, deep I hear them, lab'ring to get free;
I see the leaning strata, artful rang'd;
The fissures gaping to receive the rains,
The melting snows, and ever-dripping fogs.
Strew'd hibulous above, I see the sands;
The pebbly gravel next, the layers then
Of mingled moulds, of more retentive earths
The gutter'd rocks, and many-running clefts,
In pure effusion flow. United, thus
Th' exhaling sun, the vapour-burden'd air,
The gelid mountains, that to rain condens'd
These vapours in continual current draw,
And send them, o'er the fair-divided earth,
In bounteous rivers to the deep again;
A social commerce holding firm support.

THOM

608. The instruments for making obse tions on the atmosphere, are the *barome* which ascertains the weight of the air, and va in height between 30¼ and 28½ inches.

The *thermometer*, which ascertains the gree of heat by the expansion or contractio a fluid in the bulb, which sensibly affects quantity in a small connected tube.

Thirty-two degrees are called the freez point; and 212° is the heat of boiling wa It is hot weather at 70; but it has bee England as high as 95; and is, in winter, se times 50 degrees below the freezing point, o degrees below 0, or *zero*. At 40 degrees be 0, mercury freezes.

Obs.—Mr. Wedgewood's clay-Pyrometer meas variations of heat, as high as 30,000 degrees!

THE THERMOMETER.

there is a bulb or ball filled with quicksilver or which, distending or shrinking with heat or ies or falls the thread of the same liquid, con- n the connected tube; and the scale and figures de, indicate the relative degrees of heat and cold. ie purpose of acquiring a scale, the bulb is first into melting ice, and the place where the liquid marked; the bulb is afterwards plunged into water, and the same operation repeated. On ieit's scale, this space is divided into 180 equal nd similar parts are taken above and below, for ig the scale; and the freezing point of water is t 32°, and the boiling point at 212°.—1.8 degrees nheit are equal to one degree of the Centigrade ieter; and 2.25 to one degree of Reaumur.

THE BAROMETER.

This consists of a basin of mercury at the b
which a tube, closed at top, and open at botto
of its air, is plunged; the external atmosphe
then by its elasticity on the surface of the b
the mercury in the tube to a height equal to
force of the air; varying between 28 and 31 i
indicated by an accurate scale at the top.

606. Besides the above, there are
ters, to measure the moisture of the
gauges, to take the depth of rain; elec
to measure the electricity; and anemo
measure the velocity of the wind.

By these last, it appears, that wi
perceptible when it moves two miles in
that it is brisk, at 15 miles; high, at
blows a storm, at 50 miles; and a hur

100 miles an hour: tearing up trees, and carrying away buildings.

In England, the wind blows twice, or nearly thrice as much from the west as from the east; and the wind from the south is to that from the north, in the proportion of 3 to 2.

Of what important use to human kind,
To what great ends subservient is the wind?
Where'er th' aërial, active vapour flies,
It drives the clouds, and ventilates the skies:
Sweeps from the earth infection's noxious train;
And swells to wholesome rage the sluggish main.

605. The primary cause of all *wind* is the heat of the sun; which, during the diurnal rotation of the earth, passes over some parallel between the tropics, from east to west, every 24 hours.

Hence, as the air which is beneath the sun, is every way rarefied, there is a regular wind following the sun in the tropical parts of the world; which, in some parts, is so regular and so unruffled, particularly in the great Pacific Ocean, that the inhabitants have no idea of a change of wind, or of a storm.

Obs.—It is remarked, that the cause of all winds begins at the part towards which they flow or follow.

606. The variation of the parallel over which the sun passes vertical, from 23½ north to 23½ south, necessarily affects the winds at each pole; the heights of mountains, and local causes of heat in particular situations, also generate constant changes in the wind, in some northern and middle latitudes.

In other situations, where mountains aid the

local influ[illegible]e of the sun, regular winds [illegible] produced; w[illegible] w one-half the year in [illegible] direction, a[illegible] one [illegible]lf in another.

These are [illegible] [illegible]soons; they prevail [illegible] most parts of [illegible]a, [illegible] their changes are [illegible] tended by hur[illegible]s, [illegible]ms, and great rains.

Obs.—In the atmosphere, [illegible]ated air is constantly [illegible] ing, and colder air rushes i[illegible] to supply its place; [illegible] this event is the principal [illegible]se of winds: the air [illegible] flows from the poles towar[illegible] [illegible]he equator, in consequen[illegible] of the rotation of the earth, [illegible]s less motion than the [illegible] mosphere into which it pass[illegible], and occasions an easte[illegible] current; the air passing from the equator towards [illegible] poles having more motion, occasions a westerly current [illegible] and by these changes, the different parts of the atmo[illegible] phere are mixed together; cold is subdued by [illegible] moist air, from the sea, is mixed with dry air from [illegible] land; and the great mass of elastic fluid surrounding [illegible] globe, preserved in a state fitted for the purposes of [illegible] getable and animal life.

607. In the *northern* hemisphere, January, [illegible] every where, the coldest month; and its avera[illegible] temperature in Great Britain is 40°; and Ju[illegible] and August are the hottest months; the avera[illegible] temperature being in Great Britain 62°. In th[illegible] *southern* hemisphere, the periods vary by s[illegible] months.

The average temperature of the tropics is 8[illegible] and of the equator 84.

The temperature diminishes also according [illegible] the height above the sea; 800 feet in Gre[illegible] Britain, making a difference of three degrees and three miles on the Andes, a difference [illegible] 54 degrees.

In Great-Britain, there would be perpetu[illegible]

ow at 1¼ miles high; and there is always snow the equator, at three miles up, on the Andes.

608. Terrestrial heat is occasioned, less by e direct insulated rays of the sun, than by eir reflections from all surrouuding objects at e earth's surface; and by the heat generated the action of the rays on the surface of odies.

In some other respects, the earth has been mpared to a vast electrical machine; and the tion of the sun's rays, the winds, water, the cent of vapour, the pressure of gravity, &c., e continually generating the electrical fluid.

The air being a non-conductor, the clouds come variously electrified; and, from various uses, discharge their electricity either between ch other, or to the earth; producing shafts of *lightning*, accompanied by explosions and the shoes of explosions, called *thunder*.

Obs.—Certain changes in the forms of substances, are ways connected with electrical effects. Thus, when pour is formed, or condensed, the bodies in contact with e vapour, become electrical. If, for instance, a plate metal, strongly heated, be placed upon an electrome-r, and a drop of water be poured upon the plate, at e moment the water rises in vapour, the gold leaves of e electrometer diverge with negative electricity. Sul-ur, when melted, becomes strongly electrical during e time of congelation; and the case seems to be analo us, with respect to non-conducting substances in gene l, when they change their forms. As electricity ap-ars to result from the general powers or agencies of atter, it is obvious, that it must be continually exhi-ted in nature, and that a number of important phæno ena must depend upon its operation. When aqueous pour is condensed, the clouds formed are usually more less electrical; and the earth below them being

brought into an opposite state, by induction, takes place when the clouds approach within distance, constituting *lightning*; and the sou the air, produced by the discharge, is the cause which is more or less intense, and of longer duration, according to the quantity of air and the distance of the place where the repor from the point of the discharge. It may not resting to give a further illustration of this fa trical effects take place in no sensible time; f found, that a discharge, through a circuit of is instantaneous; but sound moves at the rat 12 miles in a minute.—Now, supposing the fl pass through a space of some miles, the exp be first heard from the point of the air agitat to the spectator; it will gradually come from distant parts of the course of the electricity; of all, will be heard from the remote extre the different degrees of the agitation of th likewise the difference of the distance, with the different intensities of the sound, and th reverberations and changes.—DAVY.

609. Rain, snow, and hail, are forme clouds, by any sudden change in the phere.

Snow, by the cloud becoming from its particles have collapsed into water.

Hail, by the freezing of the drops a have begun to fall as rain.

Dew, or *Haze*, is the falling of the va the day, when they part with their he cool of the evening.

610. The form of the clouds is found gular and systematic; and, within th years, they have been classed into kinds, worthy of being understood and bered.

a. The *Cirrus*, those of the greatest elevation and least density, parallel, and beginning with a few threads: these are accompanied or followed by steady high winds.

b. The *Cumulus*, convex or conical masses, of dense structure, formed in the lower atmosphere and the cloud of the day, but increasing about sun-set: these threaten thunder.

> Sometime, we see a cloud that's dragonish;
> A vapour, sometime, like a bear or lion;
> A tower'd citadel; a pendent rock;
> A forked mountain; a blue promontory,
> With trees upon 't that nod unto the world,
> And mock our eyes with air.——
> That which is now a horse, even with a thought,
> The rack dislimns, and makes it indistinct,
> As water is in water. SHAKSPEARE.

c. The *Stratus*, a widely extended horizontal sheet, often touching the earth or water, and properly a cloud of the night, being in the morning converted into the cumulus.

d. The *Nimbus*, or *rain-cloud*, a horizontal sheet; above which the cirrus spreads, and the cumulus enters its side and forms beneath; neither of the former appearing to rain by themselves.

611. *Fiery meteors* sometimes appear: and *shooting stars* are very frequent. Stones, also, have been often known to fall to the earth.

Northern lights, or *aurora borealis*, are frequently very interesting; and the *ignis fatuus*, or will-o'-the-wisp, affords matter of investigation.

Respecting meteors, falling stars, and north-

ern lights, nothing certain is known o
origin, or cause.

Shooting stars are supposed to be ele
phenomena; and the *ignis fatuus* is ident
hydrogen gas set on fire by phosphoric m

Obs.—The lights *seen* in *ruins*, which *often*
the ignorant, are nothing more than hydrogen g
state of combustion. The cause of candles burni
in cellars, arises, in like manner, from azotic gas.
less, also, the noises and explosions which take p
opening rooms long closed, or in which fruit h
suffered to decay, arise from the combustion and
nation of various gases. Of the fall of stones f
clouds, there is now no doubt; and it is rational
cluded, that they arise from the explosion of a
and the co-mixture of gases; but in what way th
generated, must long remain a question.

612. The discovery of hydrogen gas,
is 15 times lighter than atmospheric air
gested the plan of filling a silken balloon
it; and of its ascent in air, with an ap
appended to it, provided the whole w
than the weight of atmospheric air.

Accordingly, balloons have been fille
hydrogen gas, created by mixing iron-f
water, and sulphuric acid; which have c
through the atmosphere two, three, and
persons at a time.

Obs.—This is one of the most splendid discove
modern philosophy, but hitherto unattended by
ponding utility, owing to the difficulty of steer
machine. Mons. Blanchard made more than 6
ages in all parts of Europe; Mons. Garnerin ha
nearly as many; and Mr. Sadler, 30.—See paragra

XXVIII. *Acoustics and Music.*

613. Sound is an effect of vibration, and is produced by diverging waves of the air. This is evident, from the vibration of stringed instruments; and from the effect on Water in musical glasses.

Sound, like heat, appears to depend on the reflection of the surrounding bodies, and also on the density of the air,

Aeronauts can scarcely hear each other speak, when high in the atmosphere; and the discharge of a pistol from an air-balloon produces scarcely any report, for want of reflecting bodies.

Obs.—That bodies move, or tremble, when they produce sound, is evident in drums, bells, and other instruments, whose vibrations are distinctly perceptible; and it is equally clear, that a similar vibration is excited in the air; because bells, glasses, basins, and musical strings, will sound, merely by the action propagated from other sounding bodies, and will not sound in a vacuum.

614. The vibrations that produce sound, have been aptly compared to the circles produced by throwing a stone into the water; but judging by their effect on the water in a musical glass, the undulations are more pungent and decided.

A bell rung under water, gives the same tone as in air; and water is known in other respects to be a conductor of sound. Wood and the earth appear, also, to be conductors of sound.

615. Sounds, or their undulations, are found to travel at the rate of 1142 feet in a second, or about 13 miles in a minute.

Hence, as any corresponding light is compa-

ratively instantaneous in its progress, the
tance of the report of thunder, or of a pie
cannon, may be exactly calculated.

Sounds also are reflected like light; and
we have echoes, which are like plain mi
and whispering galleries, and repeating o
like so many concave mirrors.

Obs.—Every building standing alone, is an echo,
addressed at a proper distance; but, if there are tr
other objects to the right or left, the various echo
stray each other.

616. Speaking trumpets confine and g
limited direction to sound, independently o
mechanical effects of their reflection.

The human voice is produced by the e
sion of air from the lungs, and by the vibra
excited in that air, by a very small meml
called the glottis, in its passage through
trachea or windpipe; and by the subtle m
cations of the mouth, tongue, and lips.

Singing is performed by a very delicat
largement or contraction of the glottis, i
likewise by the mouth and tongue for u
lation.

617. The natural music of birds, and
power of singing or producing agreeable
by the human voice, led, in the course of
to the contrivance of stringed instrument
the *harp*, *lyre*, &c.; and to the inventi
wind-instruments, as the *pipe*, &c.

In stringed instruments, the air is struc
the string, and the vibrations of the air pro
a corresponding sound in the ear; but, in p

[illegible] the sides by the breath, and its vibrations or tones are produced by the reaction of the sides.

218. Sound is varied by the rapidity and momentum of the vibrating body; and this depends on the length, tension, and size of the string.

A short string vibrates quicker than a long one, and therefore produces the sharpest and shortest tones: and a short and small pipe, from the same cause, produces sharp notes; and large pipes, grave and deep ones.

Savages discovered this; and they made, and still make, instruments which please themselves and their wild companions; but art and science go further; they ascertain the causes of their pleasure, and direct them so as to increase it.

219. Hence, it was long since found, that if two strings of a harp were of equal lengths, they produced the same tone, or vibrated together, or in *unison*.

They produce the same number of vibrations exactly in the same time; their vibrations, if struck together, accord; hence, they produce the same sound to the ear.

220. It was, afterwards, found, that if one of those strings were accurately bisected, the vibrations became half the length of the vibrations of the whole, and the note twice as acute; but every *other* vibration of the half string corresponds with *every* vibration of the whole one. There is a constant *unison* or *concordance* between them; they harmonize or vibrate together

for *once* in the long string or *twice* is one.

Hence, there is no jarring or *dis* they are said to be in *concord*; and, to intervening subdivisions, have b *octaves*.

621. But as a harp, composed of only two lengths, would produce lit of sound, it was justly considered, th strings could be contrived, whose corresponded even with less frequenc *octave*, the compass and variety wo creased without discord.

Hence, as the number of vibra string is 1, while that of its octave next best division would be, to produ which, while the original vibrated 2 should vibrate 3; this was done; an which is *two-thirds* of the original, i *fifth*.

Obs.—If, then, the original string was 12 *octave* would be 60, and the *fifth* 80, or two

622. In like manner, another strin divided, so as to correspond with ev vibration of the original; and this w *three-fourths* of its length, or 90 pa and is called *a fourth*.

So on with others, whose vibratio 5 for every 4, and 6 for every 5; also 8, and 5 for every 8, till *seven* mo preceding vibrations are made of th chord.

, constructed of strings, divided in this
produces an agreeable melody; the vi-
according and agreeing with one
at equal intervals, although the tones
rent.
f a string consists of 120 parts (inches,
-corns), the *octave* will be two vibra-
, or 60 parts of 120.
th, 3 vibrations to 2, or 80 parts.
rth, 4 vibrations to 3, or 90 parts.
ajor *third*, 5 vibrations to 4, or 96

inor *third*, 6 vibrations to 5, or 100

ajor *sixth*, 10 vibrations to 6 (or 5 to
parts.
ie minor sixth, 16 vibrations to 10 (or
or 75 parts.
ese divisions of a string, constitute the *diatonic*
sole and simple object of which, is to pro-
eatest variety of tones with unisons of vibra-
exact recurrence of vibrations after the nearest

The strings of a *piano-forte*, *harp*, *or*
e brought into accordance or succes-
ves, or recurring tones, by the accu-
he ear.
harp, &c., their lengths are exactly
ned to the scale by the maker; but as
ga vary in their tension, owing to the
and other causes; and as they cannot
the same precise bulk, it is necessary,
e to time, to *tune* them; which means
nore, than to make each perform its

proper number of vibrations in relation other strings.

625. These seven notes, then, are the of all music; and, with the addition of fi tones, are the alphabet of music, and fill concordant intervals of one *octave*.

Octaves may, however, rise upon each in successive ratios or degrees, as in the forte, which has 5 and even 7 octaves; e of natural notes as above, and 5 semi-ton flats and sharps to each octave.

626. For the purpose of obtaining f variety in composing *tunes* or *melodies*, several *notes* may be played shorter or l and, in this respect, are divided as undi

2 minums make 1 semi-breve;

2 crochets make 1 minum;

2 quavers make 1 crochet;

2 semi-quavers make 1 quaver;

2 demi-semi-quavers make 1 semi-quav

32 demi-semi-quavers are to be played time of one semi breve.

Again; in regard to the tune itself, the also two sorts of *time*, slow and quick, a *mon* time and *treble* time.

627. When an agreeable succession of notes, having a perfect beginning and e is played or sung, it is called a *tune*, an *melody*; as a song, hymn, dance, or marc cording to its several purposes.

When these notes, forming an air, are bined with corresponding notes, in differe taves, or on other instruments, and the wi

ntifically made to produce a concordant and
ouble effect, it is called *Harmony*.
The *bass* and *treble* of a piano-forte played
he same time with the left and right hand,
stitute the most common practice of *har-*
ny.
ome of Handel's pieces have been played by
0 instruments and voices, all sounding har-
niously together.
te.—The human soul may be moved in all its passions
music; and as a mother of the mind, and a source of
isite pleasure, the practice on some instrument can-
be too strongly recommended as a branch of liberal
cation to children of both sexes.
" When thro' life, unblest we rove,
" Losing all that made life dear,
" Should some notes we used to love
" In days of boyhood, meet our ear;
" Oh! how welcome breathes the strain,
" Wakening thoughts that long have slept,
" Kindling former smiles again
" In faded eyes that long have wept.

" Like the gale that sighs along
" Beds of oriental flowers,
" Is the grateful breath of song
" That once was heard in happier hours,
" Fill'd with balm the gale sighs on,
" Tho' the flowers have sunk in death,
" So when pleasure's dream is gone,
" Its memory lives in Music's breath." T. MOORE.

XIX. *Of Physics; or, the General Properties of Matter.*

89. All existence is, what it appears to be
the powers of our senses; and is, therefore,
tive, or comparative, to those powers.

—Thus, there is no *intrinsic* sweetness in sugar; ...ality of sweetness is in the sense of the palate. ...olet, there is no inherent colour; but the sense ...r called violet, is in our optic nerve; and the ... sweetness produced by the same flower, is in ...ctory nerve.—So, there is no sound in a vibrating ... but the sound, so called, is the vibrating effect ...ed on our auditory nerves.—And the sense of ...ss, or substance in a stone, arises from its being ...r than our fingers, which have not power to pass ...gh it. It has been a favourite notion of ancient and ...rn philosophers, that the substratum or basis of all ...er is the same; and that all the varieties exhibited ...ur senses, are only so many modifications, capable ...producing their respective sensible effects.

2.—A person born blind, has no proper idea or ...nception of colours; he can *feel* the hardness, the ...oughness, and the length and breadth of surfaces; but ...e can have no perception of their various colours.—So ...one born *deaf*, sees the motion of a bow on a violin, ...the sticks on a drum; but has no idea of their sound. ...In like manner, all food is alike, in *flavour*, to th... who have lost their sense of taste and smell.

629. The sensations produced by things ... of ourselves, are called our *perceptions*; ... the property or *power* of bodies to exci... create particular perceptions, is, in co... language, considered as the perception ... and the body is considered as *possessi*... sensation itself, which it usually *creates*.

Obs.—Thus, we call vinegar *sour*, oil *smooth*, *hot*; though the sense of *sourness*, *smoothness*, ... is in us, not in the bodies which create those p... —So, likewise, in common language, we talk ... tion of the sun and stars; though it is only ou... moves.

630. Every collection, then, of ... capable of affecting our senses, is c... *rial*, or *matter*; and it possesses ...

lk; solidity, or the power of maintaining its ...; and *divisibility*, or the capability of ...ing divided into infinitely small parts.

Obs. 1.—Extension is *infinite*; at least, the human mind ... not *bounds* to it, but can add millions to millions ...ities in every direction.

2. Solidity is a *relative* idea; and is measured by us in ... ratio of the attraction, or centripetal force of the ...th, called *weight* or *gravitation*.—A cubic foot of pla... weighs as much as 92 cubic feet of cork, or as ...0,000 cubic feet of hydrogen gas; yet the platina it... may be *light* compared with other bodies unknown, ...d the cork and the gas be *heavy* in regard to others.

3. The property of *infinite divisibility* will be evidently, ...s the consideration that every particle of matter, ...wever small, must have an *upper* and an *under* side.—...e infinite divisibility of matter is proved by the for...ation of animalcula, already treated of, and by the ...lleability of gold. Scents are equally subtle; and it ... computed, that the millioneth part of a *grain* of musk ...vides itself into seven quadrillions of parts, in scenting ... room. So, also, the light generated by a single grain ... tallow, diffuses itself over a space two miles round, ...t it is doubted whether light is more than an undulation.

631. The followers of Sir Isaac Newton also ...cribe to matter an innate principle of at...action for matter, and assert, that all matter ...*tracts* all matter at equal distances in propor...on to the respective quantities. But a late ...riter, Sir Richard Phillips, maintains that the ...henomena ascribed to innate attraction, is a ...ere accident of matter arising from transferred ...otions, of which all matter is the patient.

Obs. 1.—Sir Richard Phillips, in his *Essays on the ...roximate Causes of the Phenomena of the Universe*, ob...rves, that Sir Isaac Newton first assumed and admitted ...e generally adopted principle of *innate attraction* as a ...ecific central force; and then, invented another force

to counteract it, which second force he [illegible] acting on the planets simultaneously at right [illegible] the other, giving it the name of *projectile force* [illegible] two forces he adopted as realities in nature, [illegible] petuate the latter, he conceived space to be [illegible]

Instead, however, of a system which has [illegible] into science such fanciful and arbitrary forces, [illegible] and Phillips is desirous of establishing a system [illegible] arising from the universal and analogous [illegible] MOTION, as it is transferred, by various [illegible] from the greatest to the smallest portions of [illegible] *asserts, that all phenomena of matter are mere* [illegible] *transferred* MOTION; *and, that known Motions* [illegible] *tent to produce all phenomena.*

MOTION, he says, is that universal principle [illegible] fers on masses of matter the power of acting [illegible] masses. In regard to matter, which is essentia[illegible] it is the source of momentum, or potentiality, [illegible] animating soul of the material Universe. [illegible] stage, MATTER is the subject, and MOTION is [illegible] producing all phenomena. Motion appears, [illegible] to be the proximate agent of Omnipotence, [illegible] necessarily a direct emanation from the prim[illegible] eternal source of all power.

2. Instead of the words *attract* and *repel*, wh[illegible] says Phillips, to false notions of causes, he pr[illegible] substitute the words to *accede* and to *discede*; [illegible] traction, *accision*; and for repulsion, *discission* [illegible] pressing the mere acts of falling towards, and se[illegible] from. Instead also, gravitate or gravitation, [illegible] poses to introduce, *centripetate* and *centripetatio*[illegible]

3. Sir Richard then proceeds to shew that a sto[illegible] has been let fall to the earth is the patient of [illegible] fold motions of the earth, the rotatory and o[illegible] and that these motions acting as forces on the st[illegible] competent to occasion it to fall to the earth [illegible] this fact he deduces the following general conclu[illegible]

That every body on the earth which has [illegible] new direction of force given to it, is nevertheless [illegible] to the permanent influence of the pre-existing [illegible] and rotatory forces in the combined lines of the

that the resulting line of motion in falling is
of all the operative forces.

t is the necessary tendency of the rotatory
give an equal momentum to the heterogeneous
nposing a planet and its atmosphere, while the
moved, by a common force, with an equal ve-
he orbit.

e force with which the deflection by the ro-
ion is produced, is as the density of the body
to the density of the medium in which it
l in the inverse ratio of the squares of the dis-
the centre.

nerefore, the phenomena, hitherto ascribed
ate, occult, universal power, called Gravita-
imple results of known local motions.

course, the laws which apply to the earth apply
e classes of phenomena in all planets; and it
erred, generally, that *the phenomena of aggre-
notidation, and local motion, in all planets, re-
heir two-fold motions around their own axis, and
ir primary.*

is, says Sir R, a *centripetal* force, or ten-
ards the centre but it does not arise from any
nciple, or from any tendency as a tendency;
nechanism, easily analysed and understood;
able to every variety of the phenomena. The
sults may correspond, but it is not indifferent
e ascribe them to a true or a false cause, or
e argue on a true or false analogy of the causes
. Thus it appears, that the *projectile* force of
unnecessary, because, if there be no universal
force, there is no necessity for a constant con-
rce to counteract it; and we thus remove an
n from philosophy.

The motions of the planets in their
ir Isaac Newton ascribes to a projec-
in a right line given them at their
from which right line they are drawn
rilinear orbits by the force of gravita-

tion to the [illegible] jectile fo
may not be [illegible] by resistance, he s
poses the space [illegible] they move to be a
cuum or void.

683. On the ot[illegible] d, Sir Richard Phil
considers space to [illegible] lled with a gas
medium, and he des[illegible] es the planetary
tions as being produc[illegible] by the action or [illegible]
of the sun on and [illegible] ough that medium
being a fact, that the sun moves around
centre or fulcrum of the masses of which
solar system is composed.

Obs.—The phenomena of the universe appear the
fore to be results of a system of MOTION transfer
MOTION, or of MOTION generated by MOTION. By
simple and intelligible agency, a stone is propelle
a planet by the motions of the planet—a planet is
ried round the sun by the motions of the sun—a sec
dary is carried round a primary by the joint motion
the sun and primary—and the motions of the sun
perhaps, caused by the motions of systems of sun
while the motions of those systems may again be cau
by other superior motions! In short, all nature con
of a series of included motions, produced by the mot
of superior bodies and systems, till we ascend to the
term in the series—to an inscrutable CAUSE of CAUSES

684. The Laws of the Force are the sa
whether the phenomena are produced by
principle of innate attraction, or by accident
motion, i. e. *the force is inversely as the square
the distance, and directly as the quantities of m
ter.—See my Grammar of Natural Philosop*

Obs. 1.—Accelerated motion, in falling bodies, is cre
by new impulses of centripetal force, acting on a b
already possessed of a given motion and which act
every instant, as though no motion were already
quired. The motion is, as the square of the times
ployed in falling. Thus,—

Seconds of time, 1, 2, 3, 4, 5, &c.
Their squares 1, 4, 9, 16, 25, &c.
Feet of motion, 16, 64, 144, 256, 400, &c.

5. The exclusion of all other active forces from nature, except the palpable one which arises from motion, transferred, transmitted, and reflected from body to body, not only simplifies our views of nature, but affords many new illustrations of natural operations. Thus, as all motion results from motion, it would appear, that animal motions are not *created* by their will, but that the will merely transfers part of the motions of the earth to certain parts of the body. If the *will* direct the motion of the hand, the will serves merely as a stream from the foot, which is connected with the moving earth, to the hand to which the energy of the foot is conveyed, as by a lever. So of all other *motions*, however complicated and diversified, they may be traced to other motions, as their origin and source. In a word, motion, as transferred by the curious mechanism of nature from body to body, is, according to Phillips, the sole and sufficient cause of all phenomena.

6. The Primary Laws of Motion are,

First, That every body will continue in its state of rest, or of uniform motion, in a right line, until it is compelled by some external force to change its state.

Secondly. That the change of motion is always proportional to the moving force by which it is produced, and it is made in the line of direction in which that force is impressed.

Thirdly. That action and re-action are always equal and contrary.

7. Several things require notice with regard to motion—

The force which impresses the motion.
The quantity of matter in the moving body.
The velocity and direction of motion.
The space passed over in the moving body.
The time employed in going over this space.
The force with which it strikes another body that may be opposed to it.

Sun ... added ...

... which the moon ... 354 days ...

... have agreed to reckon the ...

rotation of the earth round the sun ...

a year; and they again subdivide th...

12 moons, (moonths or months.)

But 12 equal moons make but 354 ...

the earth is 365¼ days going round ...

Julius Cæsar, therefore, varied the ...

we now have them, so as to make 36...

Obs.—The Hebrews and Greeks added ...

every third or fourth year; but as the revolu...

earth was a quarter of a day longer than ...

directed the 6th of March to be counted twi...

4th year, so as to keep the reckoning of ...

with that of the heavenly bodies. This, h...

not correct; for the annual revolution of the ...

quite a quarter of a day more than 365, but ...

48 minutes, and 57 seconds; consequently, ...

3 seconds, are gained every year, or a whol...

years.

will keep time, within two or seconds per annu

7. This year is als divided into 52 weeks, one day over; the week into seven *days*, or tions of the earth on its own axis; those rotations into 24 *hours*; each hour into 60 minutes; and each minute into 60 *seconds*, or periods in which a pendulum that is 39.2 inches will vibrate.

The vibration of such a pendulum, or a second, is therefore the first measure of time; but a pendulum of a *fourth* the length, will vibrate seconds; seconds are also, in calculations, divided into 60 thirds, ths, &c.

8. The names of the days of the week are derived from the names of certain Saxon objects of worship:—

Sunday, or the first day, from the *Sun*.
Monday, from the *Moon*.
Tuesday, from *Tuisco*, a German hero; whence they call themselves *Tuitschen*, or Germen.
Wednesday, from *Woden*, their god of battle.
Thursday, from *Thor*, the god of winds and thunder.
Friday, from *Friga*, the goddess of peace and plenty.
And Saturday, the seventh day, from *Seater*, the god of freedom.

—The Romans called planets:—
Solis, day of the sun; of the moon; Martis, day of Mars; day of Mercury; Jovis, day of Jupiter; of Venus; dies Saturni, day of Saturn.

639. The names of the 12 moons, [illegible] are derived from the Latin, as under:

January, from *Janus*, the god of new-born [illegible]

February, from *Februa*, the mother of Mar[illegible]

March, from *Mars*, the god of war, the [illegible] the Roman year.

April, from *Aperio*, signifying to open the [illegible] blossoms.

May, from *Maia*, the mother of *Mercury*.

June, from *Juno*, the wife of Jupiter.

July, from *Julius Cæsar*, the Roman Emp[illegible]

August, from *Augustus Cæsar*, the Roman [illegible]

September, from *Septem*, the seventh mon[illegible] man year, which began in March.

October, from *Octo*, the eighth month of the [illegible]

November, from *Novem*, the ninth month of [illegible] year.

December, from *Decem*, the tenth month of [illegible] year.

640. It will readily be supposed, [illegible] to the various lengths of years, and [illegible] rent modes of calculation practised by [illegible] nations, great differences of opinion [illegible] isted in regard to the date of past eve[illegible]

The great difficulty has been, to fix [illegible] of certain great events, as a sort of la[illegible] from which to ascertain and correc[illegible] these are—

Before Christ.

The Creation .....

The Deluge.....

The Call of Abraham .....

The Departure from Egypt .....

The Taking of Troy by the Greeks .....

The Building of Solomon's Temple .....

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* According to Cæsar, the mother of Mars was Ju[illegible] was a feast of atonement, held in the month of Fe[illegible] thence received its name.

g of Rome	753
f Cyrus	536
f Marathon	490
f Socrates	399
f Alexander	323
tion of Carthage	146
f Julius Cæsar	44
After Christ.	Years.
tion of Jerusalem by Titus	70
Empire begun at Constantinople	330
f King Arthur	514
f Mahomet from Mecca	622
f Charlemagne	820
f Alfred	890
; of William I.	1066
f Edward III.	1377
f Tamerlane	1410
ry of Printing	1440
of Constantinople by the Turks	1453
f Richard III.	1485
ry of America	1492
ation begun	1520
Armada Defeated	1588
ng of Charles I.	1640
Revolution	1688
f Blenheim	1704
an Declaration of Independence	1776
Revolution	1789
England stopped Payment	1797
f Marengo	1800
owned Emperor of France	1804
f Trafalgar	1805
f Austerlitz	1805
f Jena	1806
f Tilsit	1807
at by the Russians	1812
gs and Potentates in Europe subsi- England against Napoleon	1813
dicated	1814
dored and abdicated	1815

Obs.—The preceding dates should be accurately remembered by every one, who would talk and reason on historical facts. But there is an art of short memory, worthy of being known; by which, all numbers and dates may be *converted* into syllables, and added to the word to which the date belongs. For this purpose, a set of vowels and diphthongs, and a set of consonants, are assigned to every one of the digits; and in forming a date into a syllable, either vowels or consonants may be taken at pleasure; thus,

a	e	i	o	u	au	ou	oi	ou	y
1	2	3	4	5	6	7	8	9	10
b	d	t	f	l	s	p	k	n	s

In the vowel line, the five first digits are represented by the five vowels, and 6, 7, and 9, are diphthongs, formed from combining vowels that make up their numbers. It are the two first letters of the word eight, and y for 10, is the occasional vowel.

In the consonant line, b is the first consonant, and t, s, and n, are the first letters of their respective digits; d is the first letter of duo, two; l stands for five or fifty; p stands for 7, f as in its full sound in septem, seven; and k is the last letter in the alphabet.

As the year of the Creation can never be forgotten by the lowest intellect, I shall begin with the Deluge, and dropping age, affix a syllable to *Del*, corresponding with 2, 3, 4, 5. Looking to the table, and taking t for 3, l for 5, f for 4, and k for 5, I make the syllable *tilf*, which added to del, makes *delilfk*. Or, to vary the example, I can make a different termination by taking s for 2, t for 3, s for 4, and k for 5, which added to del, make *delstak*, either of which may be easily remembered; but the former is to be preferred, because only one syllable.

It is, therefore, an easy task for the student to make syllable terminations to all the preceding dates, and then commit the whole to memory. He may, also, extend the art to other dates, distances, and numbers, and 2 or 300, such will easily be recollected through life.

(11) History is one of the most agreeable

udices; b[illegible] there are few authentic istories.

The causes of politi[illegible] events are often unknown, and the real [illegible]cters of those who insect the affairs of [illegible]nd, are generally perverted by prejudice, [illegible]od, or flattery.

It will however be, [illegible]ful, in many respects, to be acquainted with the revolutions of empires; and for this object, recourse must be had to general and particular histories.—See *Robinson's Grammar of History*; and also his *Ancient and Modern History*.

642. It has been already observed, that the first families, or tribes, were shepherds or hunters. The quarrels of these led to wars; wars to conquest; and conquest to increased dominion, and to empire.

The first conqueror, according to holy writ, was Nimrod, a powerful hunter; who built Babylon, and laid the foundation of the *Assyrian Monarchy*.

He was succeeded by his son *Ninus*; who built Nineveh, and extended his dominions all over Asia, from India to the Mediterranean.

643. Ninus was succeeded by his wife *Semiramis*; who, for a length of time, wore a man's habit, and extended her empire over Egypt, Ethiopia, and other countries of Africa.

Her son *Ninias* succeeded her; and he had thirty successors, during a period of 1300 years, when Sardanapalus burnt himself in his palace at Nineveh; and the Assyrian monarchy was divided into the Chaldean and Persian empires.

644. These empires continued separate 200 years; when both were united by (Cy-lus) who established the *second* u empire, called *the Persian empire*, which more than 200 years. It was then con by Alexander the Great, king of Macedo in his own person, established, for a few the *third* universal empire, called *the M nian empire*; which included Greece, As he Mediterranean to the Indies, and E Africa.

645. On the death of Alexander, whic place at Babylon in the 33d year of h owing to a fever brought on by intoxicati vast dominions were divided by his ge who desolated the world by their mutu for many years afterwards.

During these ages, civilization was c to a few countries of Asia and Africa, Greece; the rest of the world was in of barbarism; and nothing is known history.

646. Soon after the death of Alexan Great, in 320, (Alexan-*der*) a new powe more to the west, the ambition of which spread its dominions over barbarous, as civilized, nations.

This was *the Roman empire*; which menced from the city of Rome, built by lus, in 753 (Rom-*ulus*) before Christ. grew it spread itself over Italy; the Greece and Africa; afterwards over the parts of Asia (except China and India

inally, over all Europe, even to Scotland, and became the *fourth* great monarchy.

647. Greece, in its greatest extent, included Hellas, Thessaly, Macedonia, Thracia, Peloponnesus, and some colonies in Asia.

The most remarkable events, which took place in Grecian history, were, the invasion of Greece by Xerxes, 480; the Peloponnesian war; and the reduction and subjugation of Greece, by Philip of Macedon.

The most celebrated political and military characters who have flourished in that country, were Miltiades, Themistocles, Aristides, Pericles, Cimon, Lysander, Alcibiades, Thrasybulus, Conon Epaminondas, Agesilaus, Phocion, and Xenophon.

648. The Roman empire, in the time of Augustus, was bounded on the west, by the Atlantic and Northern Ocean; on the north, by the Rhine and the Danube; on the east, by the Euphrates; and on the south, by the sandy deserts of Arabia and Africa.

It extended above two thousand miles in breadth, and more than three thousand in length, of chiefly fertile and well-cultivated land.

649. Among the most celebrated characters of Rome, may be reckoned Junius Brutus, Camillus, the two Scipios, Marius, Sylla, Pompey, Julius Cæsar, the two Catos, Cicero, Brutus, Cassius; all of whom flourished in the time of the Republic.

The most remarkable events of Roman history were,

The invasion of It[illegible]y the
Brennus, who plundered and burnt
Rome;

The subjugation of the Samnites
of thirty years;

The invasion of Italy by Hannibal
thaginian;

The reduction of Macedon and
The fall and destruction of the
Carthage, after the third Punic wa
The division of the empire into
by Constantine;
and the annihilation of the Roma
the Goths, Vandals, and Turks.

350. The extensive empire of G
head of which was till lately, calle
emperor subsisted in its late form
till 1806.

The most remarkable events whic
in Germany, were

The contentions between the e
the popes;

The rise and progress of the refo

And the union of the German em
kingdom of Spain, in the person of
who was the most celebrated em
house of Austria.

951. The French monarchy comm
The most remarkable events which
place in France, were

The subduing of the greatest par
by Charlemagne;

The conquest of the greater pa

English, under Edward III. and

cesses and defeats of Louis XIV.;
e late revolution in 1789.
tories and conquests of Napoleon le
786 to 1814.
ost celebrated sovereigns of France,
rlemagne, Henry IV. Louis XIV. and
, crowned emperor in 1804.
e English monarchy includes England,
Ireland, and Wales. The Saxon hep-
s united in 827; and thus was laid the
n of the kingdom of England. The most
le events in English history are
asion of the Romans;
bjugation by the Saxons;
cession of the Danish prince Canute;
nquest of England by the Normans;
ntests between the houses of York and
in the fifteenth century;
heading of Charles I.;
volution in 1688;
e separation of America.
ost celebrated sovereigns of England,
Alfred the Great, Edward I., Edward
ry V., Elizabeth, and William III.
n ancient times, the names, as well as
ons of countries, were different from
are at present: their correspondence
neath.

Latin Names.	*Modern Names.*
a, Scandia, vel	
.....	Norway and Sweden.
.....	Lapland and West Bothnia

Suiones	Sweden proper.
Gutæ et Hillevionum	Gothland.
Finningia	Finland.
Cheronesus Cimbrica	Jutland.
Sarmatia Europæ	Russia in Europe.
Hirri et Æstii vel Osiones	Livonia and Esthonia
Gallia	France.
Celtæ	Normandy, Brittany.
Aquitani	Guienne and Gascony
Allobroges, Centrones	Dauphiné and Savoy.
Lugones, Ædui, Sequani	Burgundy and Fr comté.
Lutetia Parisiorum	Paris.
Frisii	Holland and Friesla
Batavi	Utrecht and the isl the Rhine.
Belgæ, &c.	Netherlands.
Menapii, Tungri	Dutch and Austrian N
Toxandri	Antwerp.
Nationes Germanicæ	Germany.
Saxones	Upper, Lower Saxo
Rhætia	Bavaria.
Vindelicia	Swabia.
Boiohæmum	Bohemia.
Germania Sarmatis	Poland.
Hispania, vel Iberia	Spain.
Gallæcia	Galicia, Asturia, and
Tarraconensis	Navarre and Catalo
Lusitania	Portugal.
Helvetia	Switzerland.
Ambrones	Bern, Friburg, Neuf
Tigurini	Schaffhausen, Zurich
Italia	Italy.
Gallia Cisalpina	Piedmont, Milan, V
Narbonensis	Languedoc.
Tugata	Lombardy.
Samnium, Apulia, Campa Mutat	Kingdom of Naples.
Latium, Umbria, Picenum, Ar	The Popedom.
Sicilia, Sinuessa, vel Trina cria	Sicily.

el Sardinia	Sardinia.
vel Corsica	Corsica.
	Malta.
	Transylvania.
a	Sclavonia.
a	Croatia.
	Albania.
	Romania.
ssus	Morea.
	Corfu.
ia	Cephalonia.
	Candia.
	Negropont.
s	England, Scotland, & Wales.
nes	Edinburgh.
	Lanark, Dumbarton.
	Ross.
i	Cornwall and Devonshire.
	Surry, Sussex.
el Icent	Norfolk and Suffolk.
	Lincolnshire, Nottinghamshire, Derbyshire, &c.
	Northumberland & Durham.
s	Westmoreland, Cumberland
nia	Anglesey.
s	Flintshire, Montgomery, &c
	Radnorshire, Brecknockshire, & Glamorganshire
, vel Iernæ	Ireland.
	Dublin and Kildare.
	King's and Queen's County.
	Shetland and Orkneys.
nsulæ	Western Isles of Scotland.
vel Mona	Isle of Man.
ur	Natolia.
ia, Chaldæa	Irak.
nia	Diarbeck.
	Armenia.
Major	Turcomania and Georgia.
	Persia.
nichis et Albania	Georgia, Gangea, and Dagestan.

Bactriana	Balk [illegible]
Susiana	Chusestan.
Parthia	Irak Agem.
Sarmatia Asiatica	Astracan.
Sinæ	Chinese Tartary
Mauritania Tinigitana	Morocco.
Mauritania Cæsariensis	Algiers.
Numidia, Africa Propria	Tunis.
Tripolitana	Tripoli.
Cyrenaica, Libya Superior	Barca.
Ægyptus	Egypt.
Libya Inferior, Gætulia	Biledilgerid.
Solitudines	Zaara, or the Desert
Antoloies	Negroland.
Æthiopiæ, et Libyæ pars	Upper Ethiopia.
Æthiopiæ pars	Lower Ethiopia.

N. B. For other particulars, consult Dr. R[illegible] Grammar of History, and his Ancient and Mo[illegible]tories.

XXXI. *Mythology.*

654. MYTHOLOGY, Fable or Fiction, [illegible] creature of the imagination, and derives [illegible]gin from a love of the marvellous and wo[illegible] a passion, of which legislators and teach[illegible] early ages of society, took advantage.

Obs.—These tales of ignorance, barbarism, an[illegible]stition, fill a large portion of many books of ed[illegible] but these few pages will suffice on this subject.

655. As a means of civilizing the wo[illegible] priest and the poet, among ancient nation[illegible] use of the same means to convey their [illegible] and instructions to the vulgar.

It was often, also, a mode of honouri[illegible] ever was useful or honourable in natio[illegible] Chinese having their Fohi; the Hindo[illegible]

Indians) the Greeks and Romans, their Jupiter; and the Scandinavians, their Woden.

656. Mythology was first reduced to a system by the Hindoos; and afterwards, by the priests of Egypt, who were the depositories of Eastern learning, as well as religion, and who monopolized all the arts and sciences.

657. Fables are the tales of former times, when there existed neither records nor chronology.

By the Chinese mythology, *Fo* or *Foki*, probably (the Noah of holy writ), the founder of their empire, was born in a supernatural manner, and was inspired by heaven with knowledge which qualified him to teach all arts and sciences, and compose their laws.

Of their *Confucius*, they believe, that he was not born as other men; but able to reason profoundly from his childhood

658. The mythology of the Hindoos is much connected with their casts or tribes; into which the Indian nations are divided.

Some of their fables relate to the creation, to the general deluge, and to Vishnu or Brahma who, they say, was miraculously born; (in Sweta, the White Island, or Britain!) and that at thirty, he began to promulgate his doctrines which have since spread all over India, and a great part of Asia.

His principal dogma, was that of the transmigration of souls, after death, into the bodies of other animals;—a doctrine which gave rise to idols in the shape of monsters, quadrupeds, &c.

650. The Persians supposed the w
have been repeatedly destroyed; but re
by creatures of different formation, w
been successively annihilated for disobe
Supreme Being.

Their mythology related to the ex
Tahmuras, one of their ancient kings,
tacked and vanquished the daemon that
the happiness of the country; and als
labours and adventures of Rostan, anot
him chief, similar in character to the l
of Greece and Rome.

660. In the Egyptian mythology, the
lions of the heavenly bodies, are referr
reigns of their early monarchs.

Hence, the number of years included
reigns of the superior gods who filled t
tian throne; and to these, they say, an
twelve demi-gods.

The imaginary exploits and absurd
tures of the gods and demi-gods, form
inexhaustible fund of mythological rom

661. The adventures and exploits o
Osiris, Typhon, and Isis, and the transfo
of the gods into various animals, are t
dations of the Egyptian mythology.
animate and inanimate were, at first, e
emblems of the deities, and were wors
deities.

Thus, Jupiter Ammon was worshipp
the figure of a ram; Apis, as a cow; M
a bull; Pan, as a goat; Thoth, or Mer
an ibis, &c.

Thoth, or Mercury Trismegistus, was
presented as the inventor of letters, geo-
astronomy, music, architecture, and all
inches of science and philosophy, in
there is no doubt the Egyptians greatly
l.

The mythology of Greece is partly
l on that of Egypt; and is furnished
by the adventures of Jupiter, Juno, Mi-
Neptune, Venus, Mars, Vulcan, Vesta,
Diana, Ceres, and Mercury.

les these twelve deities, called the supe-
ls, there were second and third classes
, and a multitude of others, of inferior
but connected with them.

Jupiter, or the *Thunderer*, was esteem-
most powerful of the Grecian gods, and
i of Saturn and Rhea. After delivering
ier from the tyranny of the Titans, he
master of the universe, which he divided
s brothers; reserving heaven for himself,
the sea to Neptune, and the infernal re-
) Pluto.

ng overcome his enemies, he gave himself
all kinds of pleasure; but notwithstand-
tained universal homage and worship.

/as the king and father of gods and men;
ver extended over all the deities, and
hing but the Fates was subservient to

/as the Vishnu of the Hindoos, the Osiris
pt, the Ammon of Ethiopia, and the
of Babylon.

665. *Juno*, the sister and wife of Jupiter, was famous for her jealousy, her implacable temper, and her quarrels with Jupiter. She presided over empires and riches; and was worshipped with solemnity, as the protectress of married women.

She had three children, viz. Hebe, Mars, and Vulcan. Iris, the rainbow, was her chief attendant.

666 *Minerva*, the goddess of wisdom, sprung from the head of Jupiter; she was the patron of the arts, and an emblem of wisdom and prudence. The cock and the owl are emblems of of her valour and wisdom.

667 *Neptune* was worshipped as the god of the ocean. He was ruler of the seas, and held dominion over all maritime affairs. Polyphemus, one of the Cyclops, was his child, and a giant who devoured all who fell into his hands.

668. *Venus*, the goddess of love and beauty, said to have sprung from the froth of the sea on the surface of which, she was wafted in a shell to the island of Cythera. On the sea, she was surrounded by Cupids, Nereids, and Dolphins, and in the heavens, her chariot was drawn by doves and swans.

669 *Mars* was represented as a warrior riding in a chariot drawn by horses, driven by a Fury. Discord preceded them, and Destruction, Rage, Fear, and Terror, attended his progress.

The dog for his vigilance, the wolf for his fierceness, the raven for feasting on the bodies

, the slain, and the cock for his watchfulness re dedicated to this god of war. Bellona wa a sister.

670. *Vulcan* was the god of fire and of works s of metals, and the inventor of the art of fa- icating arms and utensils from metals. Tem- es were erected to him at Athens, Rome, &c., d, at Memphis, a magnificent one was dedi- ted to him, before which stood his statue, se- nty feet high.

He was said to forge the armour of the gods, d the thunder of Jupiter. He was the son of piter, the husband of Venus, and the father Cupid.

671. *Vesta* was the daughter of Saturn, and e goddess of fire; an altar was raised to her; d virgins, called Vestal Virgins, were em- oyed in maintaining the sacred fire which rned in the temples in honour of the goddess.

Obs.—The temple of Vesta, at Rome, was supposed to ntain, besides the sacred fire, the household gods which neas saved from the destruction of Troy.

672. *Apollo*, the son of Jupiter and Latona, resided over the fine arts, and was skilled in e practice of music; he is represented with s lyre, and crown of laurel.

Diana, the sister of Apollo, was goddess of nstity, of the chace, and of the woods. She as adored as Luna in heaven, as Diana on rth, and as Hecate in the infernal regions; d was generally attended by Cupid, Hymen, the Hours.

[illegible] Ceres, the goddess of [illegible] fruitfulness, is said to have taught the [illegible] the earth, sowing corn, and making [illegible] she had a daughter named Proserpine.

674. *Mercury*, the messenger of [illegible] was the inventor of letters, and of the [illegible] sciences; also the *reformer* of [illegible] denominated Hermes, for his eloquence. [illegible] represented with wings fixed to his cap [illegible] dala; and in his hand, a caduceus [illegible] round which are entwined serpents.

675. There were also numerous other [illegible] personages, who had inferior parts [illegible] them; as

Saturn, the father of Jupiter, and [illegible] Heaven and Earth. His wife was [illegible] Cybele.

Pluto, the son of Saturn and Ops, [illegible] the infernal regions, and ruler of the [illegible] called from his teaching the rites of [illegible]

Bacchus, who presided over the [illegible] the god of wine.

Hebe, the goddess of youth, &c.

676. The three *Graces* were daughters [illegible] piter, by Eurynome; and the nine [illegible] Mnemosyne. He was also the father of [illegible] and *Diana*, by Latona; and of *Mercury* [illegible] Maia.—*Minos*, *Rhadamanthus*, and *Æacus* [illegible] inexorable judges, who examined the [illegible]

Tisiphone, *Alecto*, and *Megæra*, [illegible] gaolers and executioners of *Tartarus*, [illegible] armed with snakes and lighted torches;

Charon conducted the souls of the dead across the *Styx*, where they drank the waters of *Lethe*, or oblivion.

677. The Elysian Fields were the paradise of the good. The Fates were *Clotho*, who held the distaff; *Lachesis*, who spun the thread of destiny; and *Atropos*, who, with his scissars, cut it asunder.

Hercules, or Alcides, the virtuous hero of antiquity, was the son of Jupiter and Alcmena, and performed twelve famous labours, among which, were the killing of the Nemean lion; and the cleansing the stable of 2000 oxen of king Augeas in one day, which had not been cleansed for thirty years.

Amphitrite was the mother of the Nereids, who, with syrens and tritons, attended Neptune.

Somnus was the god of sleep; *Morpheus*, of dreams; *Erebus*, of darkness; *Nox*, the goddess of night; *Plutus*, the god of riches; and *Momus* of folly.

678. In the mythology of the northern nations, *Odin* or *Woden* was the chief divinity.

His exploits and adventures furnish the principal part of their mythological tales. He is supposed to have come from the east; and is represented as the god of battles, and as killing thousands at a blow.

His place, called *Valhalla*, was situated in the city of *Midgard*, where the souls of heroes who bravely fell in battle enjoyed supreme felicity, and spent the day in hunting matches or combats; and at night, assembled in the palace

of *Valhalla*, where they feasted on [illegible] [illegible] provisions, and drank [illegible] mead, the Scandinavian nectar, out of the skulls of their enemies.

679. *Sleepner* was the horse of Odin [illegible] *Hela*, their hell, comes our word *Hell*; from *Sinna*, the wife of the evil genius, our word *Sin*.

They had giants also, called [illegible] [illegible], and [illegible] called *Fola*, whence comes our word [illegible]

Their *Volaspa*, or book of prophecies, contained the history of the world, [illegible]

[illegible]

XXXII. *Drawing, Painting*, [illegible]

680. Drawing is that art [illegible] which teaches us to represent [illegible] likenesses of men and things. It is a source of pleasure; because it enables us to familiarize ourselves with the most beautiful and grand objects; and it is, at all times, an agreeable recreation.

It is practised on paper with chalk, black lead, crayons, Indian ink, and water colours; and on board and canvas, with oil colours.

*** See Hamilton's Practical Elements of Drawing, with its numerous engravings, [illegible]

681. In learning to form the hand, the student should begin with [illegible] copying [illegible] cylinders, and globes; and these he should shadow, so as to give the effect of solidity.

He may then proceed to inanimate objects, as lowers, fruits, trees, and houses, giving each its proper light and shade; thence, to animals; nd, finally, to the human figure, at first naked, nd then clothed.

682. To draw a landscape or groupe of igures, a knowledge of perspective is required; nd this is nothing more, than the art of representing every object in its proper bearing, and nder its proper angle, which angle is always n *proportion to the distance of the object from he eye.*

Just conceptions should also be formed of ight and shade; the foundation of which is the bvious principle—that *the light always proceds from one point*; and, consequently, that ll shadows fall one way. The true disposition f light and shade, is called *relief*.

Obs.—To give effect to particular objects, the student ust copy the subjects from Hamilton: and after doing his for some time, if he have genius or taste, he will begin o copy nature, and afterwards contrive for himself, and esign originally

683. The art of drawing in PERSPECTIVE, urposes to represent every object in its proper lace and relative size and figure, as it is seen rom the spot where the view is taken.

The eye of the draughtsman is supposed to e fixed; and he is to pourtray every object, s though he saw it on a pane of glass, the size f his paper or canvas.

The general principles are not difficult, proided two or three technical terms are well underetood.

684. The *ground-plane*, is the plane or level, on which both the spectator, and the objects that are to be drawn, stand.

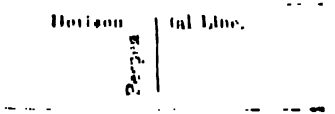
The *perspective plane* is a supposed plane standing perpendicularly upon the ground-plane; and on this plane, as on a pane of glass, the images of objects are supposed to be intercepted; so that their perspective appearance, when drawn, is the appearance they would have on this plane.

The *ground line* is the line on which the perspective plane is supposed to rest.

685. The *point of sight*, is that point in the perspective plane which is nearest or opposite the eye; and is at the same proportional distance from the ground line, as the height of the eye is above the ground plane.

The *horizontal line*, is a line upon the perspective plane, drawn through the point of sight, and parallel to the ground line.

The *perpendicular*, is a line on the perspective plane, drawn through the point of sight, perpendicularly to the ground line, and to the horizontal line.



the point A, where the perpendicular and horizontal es cross, is the point of sight, or vanishing point, of lines perpendicular to the perspective plane.

686. *Points of distance* are points on the perctive plane set off from the point of sight; metimes on the horizontal line, sometimes on e perpendicular;—at the same proportional tance from the point of sight, as the eye itself from the objects.

Measuring points are points, from which any es in the perspective plane are measured, by ing a ruler from them to the divisions laid wn upon the ground line.

Vanishing points are points, on the perspece plane, in which parallel lines seem to meet, vanish:

687. The rules for drawing are,

1. That all lines perpendicular to the groundne, should be perpendicular to the groundé; and all lines parallel to the perspective ne, must be drawn parallel to each other.

2. That all *parallel lines meet, or have vaing points,* in some part of the perspective n.

3. If the lines lie upon the ground-plane, y will vanish somewhere in the horizontal e; which is, therefore, called the vanishing e of the ground-plane.

4. If parallel lines be perpendicular to the und-line, they will vanish in the point of ht.

5. If they be oblique to the ground-line, or e a declination from such perpendicular, then

the angle of this obliquity or declination must be set off.

688. All the measures of lines upon the ground-plane, are to be laid down upon the ground-line, and the measuring point of all lines parallel to the ground-line, is either of the points of distance on the horizontal line, or the point of sight.

The measuring point of any line, perpendicular to the ground-line, is in the point of distance on the horizontal line; and the measuring point of a line oblique to the ground-line, is found by extending the compasses from the vanishing point of that line to the point of distance on the perpendicular, and setting it off on the horizontal line.

OBS. The above rules committed well to memory will, with some practical instructions from a master, or by practice only, enable the student in drawing, to place all his objects in due perspective.

689. The art of painting in oil-colours is the most deservedly admired of scientific arts, when carried to perfection. The requisites of a great painter are,

Correct drawing, without which, all other art is lost:

Just perceptions of *grace* and *beauty*:

Invention, which implies a perfect knowledge of his subject in all its relations, and a choice of the subject adapted to his art:

Composition, or the agreeable distribution, and effective grouping, of his figures and objects, in his rough, preparatory *design*:

Colouring, or the imitation of nature in her ppiest moods; this branch of art avoids all ident transitions and unnatural glares, and iders distant objects less distinct than near es.

" The Poet dreams—the shadow flies,
" And fainting fast, its image dies,
" But lo! the Painter's magic force
" Arrests the phantom's fleeting course.
" It lives—it lives—the canvass glows,
" And tenfold vigour o'er it flows.
" The Bard beholds the work achieved,
" And as he sees the shadow rise,
" Sublime before his wond'ring eyes,
" Starts at the image his own mind conceiv'd."

H. K. WHITE

690. Paintings, in regard to their subjects, e called historical, landscape, or portrait; d to the painters, they are divided into hools or countries:

As, The Italian school,
The German school,
The Flemish school,
The Dutch school,
The French school,
And the English school.

Each of these schools has treated the prace of painting in its peculiar manner, and ch, with exquisite beauty and admirable ect.

Obs.—Nothing can be more unlike, than an historical nting of the Italian and Dutch schools; nor than a trait of the German and English schools; yet, each its admirers and distinctive merits.

691. The great masters of the *Italian* school, re Michael Angelo, Raffaelle or Raphael, Ti-n, Corregio, the three Carraccis, Carlo Ma-

patti, Carlo Dolci, Guido, del Sarto, Parmegiano, Salvator Rosa, Romano, Caravaggio, Paul Veronese, and Guercino: besides a hundred others, some original, and some copiers of the great masters.

The great painters of the *German* school, were Albert Durer, Holbein, Kneller, and Mengs.

602. Of the *Dutch* school, were Rembrandt, Gerard Dow, Mieris, Ostade, Polemburg, Berghem, and Wouvermans.

Of the *Flemish* school, were Rubens, Teniers, Jordaens, and Vandyck.

The admired painters of the *French* school, are Claude, Poussin, Le Brun, Le Sueur, Vien, and David.

The *Spaniards* also have had their Murillo, and Velasquez.

603 The eminent painters of the *English* school, are Hogarth, Wright, Reynolds, Wilson, West, Northcote, Gainsborough, Morland, Barry, Copley, Westall, Davis, Burke, Tresham, Wilkie, Daniel, Turner, Gerrard, Lawrence, Pocock, Bone, Opie, and many others still living, whose works may be seen in the annual exhibitions of the Royal Academy.

XXXIII. *Heraldry.*

604. During the Holy Wars, and the ages when close armour was worn, the warriors *emblazoned* or painted their *shields*, and wore *crests* in their *helmets*, to distinguish them in the field of battle.

were, in subsequent periods, borne h
by their families; and the methods of
a shield were reduced to a science;
erally used, and, therefore, of cours
to be understood.

he tatooing of the natives in the South Sea
and the figures painted on the bodies of the
Britons, may be considered the heraldry of
for both with them and civilized nations, this
ed back to superstition and slavery.

Heraldry is the art of blazoning or dis-
coats of arms, in proper colours and
on the *shield* or *escutcheon*.

points of an escutcheon are *nine*:—
on the upper part; of which, the middle is
chief; that in the right corner, the *dexter chief*;
n the left corner, the *sinister chief*.
perpendicularly in the middle part of the shield:
called the *honour-point*; the second, the *fess*-
e third, the *navel-point*.
points horizontally, at the bottom: the middle
ed the *base-point*; the other two, the *dexter* and
se points.

Tinctures are armorial colours; as *or*,
nd *argent*, silver; *azure*, *gules*, *sable*,
d *purpure*; and *ermine* and *vair*.

These colours are represented on copper-plate
follow: 1. *Or*, is known by small pricks or
2. *Argent*, by the natural whiteness of the
ithout any strokes or points. 3. *Azure*, by
r strokes across the shield from side to side.
by lines from top to bottom. 5. *Sable*, by
rossing each other. 6. *Vert*, by hatches from
hief to sinister base. 7. *Purpure*, by hatches
ister chief to dexter base. 8. *Tyrus*, by cross
rom right to left, and from left to right. 9. *Ver-*
hatches from right to left, and others from side

697. Of the nine honourable charges.

The *cross* signifies afflictions for religion;

The *chief* denotes that the first bearer was a person in authority;

The *pale* imports him skilled in mining;

The *bend* shows him to have been valiant in war;

The *fess* denotes a worthy general;

The *inescutcheon* shows him to have been one who disarmed his enemy;

The *chevron* declares him to have been the head of his family;

The *saltier* implies he behaved honourably at some siege;

And the *bar* shows him to have been serviceable in raising fortifications.

698. The lines which compose or bound these charges, are esteemed additional notes of distinction; as, invected, ingrailed, waved, nebulee, imbattled, raguled, indented, &c. They are always mentioned in blazoning; as, a chief invected, a pale ingrailed, a fess indented, &c.

699. The field of the escutcheon, is generally divided into two or more equal parts, by lines across the same; which partition must be mentioned in blazoning.

Thus, if a line perpendicular to the horizon divide the shield equally, it is said to be parted *per pale*; if the line be parallel to the horizon, it is parted *per fess*; if from right to left, it is parted *per bend*; and so of any other.

700. *Common Charges* are those figures which are painted within the field of the escutcheon; and they are taken from every kind of beings, natural and artificial.

a. Angels, *cherubim*, &c. denote celerity in business, messengers of peace, &c.

b. Men are honourable ensigns, as *saints* show that the first bearer was some bishop, &c. *Heads* show him to

r done service against Saracens, Turks, &c. *Hinds* rms signify strength and fortitude. *Eyes* denote his gment. *Legs* and *feet* indicate his swiftness: and the f knowledge and understanding.

Beasts of prey are more honourable than beasts of e. The male is more honourable than the female. whole is nobler than any of the parts; the natural roper colour is better than any other. The free and lar posture, than the irregular and constrained.

Of *birds*, the female is more honourable than the , except the cock. Their native colours are better artificial; and birds of prey, as eagles, falcons, &c. most honourable.

Of *fishes*, the dolphin is the principal; and the most urable bearing of fish, is *nayant*, or swimming: the , *springing*; and then *hauriant*, or in an erect ure.

Insects are rarely borne in arms; but the Ant de- s industry; and the Bee, a laborious and beneficent ion.

01. The postures are of great account; as, *chant*, lying down; *passant*, walking; *com-* fighting; *rampant*, reared on his right to fight; *saliant*, leaping at; *guardant*, ing towards you; *regardant*, looking back behind; *dormant*, sleeping; *seiant*, sitting the forefeet straight; *endorsed*, two in a pant posture, with their backs towards each er.

02. The chiefs, or heads of families, or ses, bear two sorts of charges: a *label* of e points; and *border*, which are either n, compound, indented, &c. For consan- uity, or kinsmen, the differences are accord- to the branch of a family from which they inally descended.

First son	Bears	A label with three points.
Second son		A crescent .....
Third son		A mullet .....
Fourth son		A martlet .....
Fifth son		An Annulet .....
Sixth son		A fleur-de-lis .....

703. Since these are the bearings of (tion for persons of the first house; t the second house, which is the family second son, have their distinctions as fol

The	Eldest son	Bears a cre[scent] with	A label
	Second son		A crescent
	Third son		A mullet
	Fourth son		A martlet
	Fifth son		An Annulet
	Sixth son		A fleur-de-lis

upo

In like manner, the sons of the third bear those differences respectively on a the fourth, on a martlet; the fifth, on a let; and the sons of the sixth house bea on a fleur-de-lis: and though there ferences for every son, yet there are n daughters, as they are all deemed equal i of honour.

704. Of hatchments, or funeral *ments*, the following things are observabl

1. When a batchelor dies, his arms may be single or quartered, but never impaled; and

ment he may bear a crest, and the ground without
utcheon must be all black.
f a maid dies, her arms must be placed in a lozenge
mbus, single or quartered, with the ground all
; and the hatchment must have a shell over it in-
of a crest.
When a married man dies, his wife's arms are im-
with his down, with the ground black on his side
hatchment, and white on his wife's side.
When the wife dies, the arms are with the ground
side black, but on her husband's white; instead
est, her hatchment must have a shell over it.
f a widower dies, his arms are impaled with those
wife, with a crest, &c., and the ground is all

f it be a widow, her arms with her husband's, are
d within a lozenge shield, with a shell over it, in-
of a crest, and the ground all black.
When the deceased is the last of a family, then, in-
of a crest or shell, there is placed on the hatchment
's head. Little shields, that draw hearses at pom-
unerals, are called *chaperonnes*.

XXXIV. *Literature.*

5. After the invention of letters, the genius
in taking different directions, some of them
led in poetical, and some in prosaic com-
ions. These again assumed different cha-
rs, according to the subjects treated of.
nce we have in *Verse*, epic poems, de-
tive poems, and elegiac, dramatic, and sa-
l poems:
d in *Prose-writin*, we have historical, de-
tive, didactic, and epistolary compositions
almost infinite va sty of kinds and qua-

706. Poetry is the glowing [illegible] passioned feeling, generally [illegible] lines, and often in rhyme.

Most ancient people have had and among the Hebrews they we phets.

David was an inspired poet of

Homer, one of the earliest poets

Ossian, an ancient poet of the

Taliesen, an ancient poet of th

And Odin, an early poet of vians.

707. The Greeks were the fat literature, philosophy, and arts the first, and the prince of poets brated the siege of Troy in the I ey, two epic poems, which ne perhaps, never can be surpassed.

In the same line of poetical co was followed, after 900 years, by Æneid:

By Tasso, after another 1500 Jerusalem Delivered:

And by Milton, about 150 ye radise Lost;—the finest poem ev the Iliad.

708. The Greeks, besides, bo Pindar and Anacreon, in lyric p Aristophanes, Euripides, Sophocl lus, in dramatic poetry.

After them, among the Rom Ovid and Tibullus; among drama and Terence; of didactic and phil

l also Lucretius, Virgil, Horace, and
ireus.

ese were so many miracles of human
and their works afford so many models
pective species of composition.

lost of the works of the ancients have, in recent
t in spirit, been translated into English. Thus,
ope's and Cowper's *Homer*; Dryden's *Virgil*;
ulus; Colman's *Euripides* and *Sophocles*;
id; Busby's and Good's *Lucretius*; Francis's
nd others.

pproaching nearer to our own times,
erature of the ancients, after a long
noukish superstition and darkness, was
Italy in the 15th century, so the first
of modern literature were made in
ıtry:

, their Dante, Ariosto, Petrarch, and
ho were followed, in *France*, by Racine,
, Boileau, Voltaire, Fontaine, and

n *England*, by Chaucer, Spencer, Shak-
ilton, Dryden, Pope, Thomson, Young,
nd Gray.

lesides these great names, we have had
d, at least, twenty other poets; whose
ould vie with others of any age or

we have in didactic and sentimental
ur Goldsmith, Cowper, Darwin, Ma-
lison, Johnson, Akenside, Armstrong,
Blackmore, W. Dyer, Robinson, Watts,
nd, Dermody, and Beattie.

In satirical poetry, Butler, Anstey, and Churchill.

In pastoral, Shenstone, Gay, Cunningham, and Ramsey.

In lyric poetry, Cowley, Smith, and Burns.

Obs.—Among admired living poets, may be named Wolcot, Crabbe, Rogers, Southey, Coleridge, Rogers, Campbell, Bloomfield, Wordsworth, Cottle, Bowles, Colman, Shee, Taylor, Barbauld, Byron, Moore, Maythias, Scott, Dibdin, and some others; whose meritorious works will be impartially judged and estimated by a future age; but to which, for the present, we can only wish due immortality.

"The Poet! hallow'd, honoured name!
"The dearest, eldest child of Fame!
"While life remains, green laurels grow
"A garland for the Poet's brow;
"But oh! what greener flowers shall bloom
"Eternal round the Poet's tomb?
"The fairies all shall leave their cells,
"Where Love with Peace and Plenty dwells,
"The mossy cave, and sylvan grot,
"To weep around the hallow'd spot;
"The Seasons as they wander by
"With liberal hand, and sparkling eye,
"Shall pause to gaze on scenes so fair,
"And strew their sweetest garlands there:
"And oft amid the night's profound
"When solemn stillness reigns around,
"The mystic music of the spheres,
"Reveal'd alone to gifted ears,
"In dirges due, and clear shall toll
"The knell of that departed soul." ROSA.

711. Poetry is classed under the heads *epic*, or heroic; *dramatic*; or representative; *lyric*, or suited to music, as odes, songs, &c.; *didactic*, or instructive; *elegiac*, or sentimental and affecting; *satirical, epigrammatic*, or witty and

icrous; and *pastoral*, or descriptive of rustic

ersification, in the English language, de-
ds on the length and shortness of syllables,
modulation of the accents, and the disposi-
of the pauses. It is either rhyme, or re-
ring rhyme, alternate, or interchanging
me, or in triplets of three lines; or blank
e, the noblest and grandest of all our mea-
s.

12. The heroic verse consists generally of
syllables; and its harmony depends on the
ular distribution of accented and unaccented
ables; and its character of solemnity or
liness, depends on the order, and length or
rtness of those syllables.

Thus, when the accent is on every other syl-
e, it is called *iambic* verse; as,

A *shepherd's boy*, he *seeks* no *higher name*,
Led *forth* his *flock* beside the *silver Thame*.

13. The monotony of recurring accents, is
iated by the varied disposition of the *cesural*
se. When this pause is on the fourth sylla-
the strain is smooth and airy; as,

ft is the strain | when zephyr gently blows,
nd the smooth stream | in smoother murmur flows.

Or, it is still quicker, when placed at the
nd syllable; as,

Not so | when swift Camilla scours the plain.

But, as in the first instance, our heroic measure
is of great variety in its composition: *Soft* is being
chee; *and the* being a pyrrhic; and the *smooth*
as a spond

714. The following [illegible] ribus pauses, which give us many [illegible] fects to the lines:—

O friend, | may each domestic [illegible]
Be no unpleasing melancholy | [illegible]

Or,

Me | let the tender office long [illegible]
To rock the cradle | of declining [illegible]

Or,

O cruel, beauteous, | ever lovely,
Is it in heaven | a crime to love [illegible]

715. The *anapestic*, is where the [illegible] on every third syllable; as,

I am *monarch* of all I survey,
My *right* there is none to dispute
From the centre all round to the [illegible]
I am *lord* of the *fowl* and the [illegible]

Or,

'Tis *night* | and the *land*scape is *lovely* [illegible]
I *mourn*, | but ye *wood*lands | I *mourn* not [illegible]
For *morn* is approaching, your *charms* [illegible]
Refreshed with fresh *fra*grance, and *glit*'trin[illegible]

Various other kinds of verses are [illegible] in the works of the poets; but the [illegible] most common.

716. The first historian among the [illegible] was Herodotus; they had also Thuc[illegible] Xenophon.

The orations of Demosthenes [illegible] are master-pieces of eloquence.

The moral writings of Epictetus, [illegible] Plato, are deservedly cherished.

In philosophy, Aristotle was a [illegible] wonderful genius; and Euclid and [illegible] were the fathers of geometry and mus[illegible]

also carried painting and statuary to the pitch; of the former, we have no per- cimens; but the statues of Phidias and les are still unrivalled.

The Greeks were followed by the Ro- in history, by their Livy, Tacitus, Justin, is, and Sallust;

oquence, by Cicero;

orals, by Seneca, Pliny, and Plutarch.

iticism, they had their Quinctilian and us; and numerous other writers in every of knowledge.

Romans were followed by the ITALIAN ardini, Davila, Petrarch, Poggio, &c.

NCE boasts of its Montesquieu, Voltaire, ibert, and Marmontel.

MANY, of its Schiller, Kotzebue, Klop- nd Wieland.

SPAIN of its Cervantes and Lopez de

The genius of ENGLAND, favoured by l liberty, has proved itself little inferior of ancient Greece; it has excelled in ranch of literature.

storical compositions, we have had Cla- Robertson, Hume, Gibbon, Belsham, , and Gillies;

orals, Locke, Addison, Johnson, Swift, rworth, Paley, and Blair;

ilosophy, Bacon, Harvey, Newton, Boyle, Priestley, Halley, Franklin, Hunter, y, and Jenner;

In legislation, Coke, Blackstone, and Mansfield;

In mathematics, Briggs, Newton, Simpson, Emerson, Waring, and Hutton;

In chemistry, Black, Priestley, and Da[illegible];

In agriculture, Young;

In romance, Richardson, Fielding, [illegible], Smollet, Sterne, and Burney.

719. To concentrate and give effect to individual labours, societies have, latterly, been formed in all parts of the world: and on these now depend, in a great degree, the further improvement of man.

Thus, in England, we have the Royal Society, the Antiquarian Society, the Royal Academy, the Society of Arts, and the Board of Agriculture.

In [illegible], there is the Imperial or Royal Institute, and at Berlin, Madrid, and Petersburgh, royal societies like those of London.

[illegible] has its societies; and there are others in India; all labouring for the promotion and propagation of knowledge.

[illegible] has been given to study; and [illegible] been accelerated, in every branch of [illegible] of the Art of Printing. In England, [illegible] this art is the means of producing [illegible] per annum, besides 70 [illegible] and 250 several newspapers. Of the Monthly [illegible] estimated the best in Europe, nearly 5000 [illegible] and of all the monthly works, at least [illegible] per month. Of the newspapers throughout the [illegible], above half a million are [illegible]

QUESTIONS.

TO THE

VERSAL PRECEPTOR.

Questions on Chap. I. *to* VII.

rt was not common to all savage life?
ras the probable discovery of metals?
art of a column is the capital?
orts of grain best suit stiff soils?
two people lived on an acre in England, how
y inhabitants would it support?
re the English effecting for the people of Hin-
i?
what nations is there at this day no property in

hanges do silkworms undergo?
were the substitutes for glass windows before the
tion of glass?
was the mode of life among the earliest families?
were the ancient qualifications of a chief?
are the native or indigenous fruits of England?
root did Raleigh bring from America, and when?
at classes of minerals are chalk, diamond, gold,
and salt?
currency is pernicious, and why?
are the improved breeds of sheep in England,
hat is the value of the fleece of each?
is the use of tan-pits?
is the warp in weaving,
is the most convenient material for building, and
obtained?

20 What is an *oxyde*?
21 What number of pounds per day would an acre of ground produce in mutton, potatoes, peas, carrots, or parsnips?
22 How many horses are employed in purposes of pleasure?
23 What is meant by rotation of crops, and what is the use of it?
24 What savage people were without the use of fire?
25 What is the condition of man in a savage state?
26 How many different kinds of grass are there, and what are the two principal subdivisions?
27 What is the use of knowledge?
28 How many farms might there be in England and Wales, if they were all of the smallest beneficial size?
29 What are coals, and where are the principal coal works?
30 Which is the heaviest, and which the lightest of the metals, and how many pounds of the lightest will make ten pounds of the heaviest?
31 What metal is essential to agriculture?
32 What is the process called by which fruits are improved?
33 What is paint made of, and for what purpose?
34 What is glass made of, and how was it discovered?
35 How many orders of architecture are there? and trace them or copy them neatly.
36 What is the chief manufacture of Lancashire and Lanarkshire?
37 How many unwound cones of raw silk will extend round the world?
38 What breeds of oxen are the most preferred?
39 What are stiff, what light, and what barren soils?
40 What people go a week without food?
41 What was the condition of the ancient Britons?
42 What is lime used for?
43 Where is the greatest quantity of silk produced?
44 What are the people who live in wigwams, and who those that live under ground?
45 How many people in England eat up ten oxen in a year?
46 If all the inhabitants of Great Britain ate potatoes only, and each ate six pounds per day, how many more people might be maintained than at present?
47 What poet has so well described a cotton-mill? and transcribe and repeat his lines.

: is linen made of, what ropes, and what callico? and
cribe the processes.
is wool prepared?
is metal separated from the ore?

Questions on Chap. VIII. IX. X. XI.

t is the general principle of the mechanical powers?
will not water rise 60 feet in a pump?
at is a ducal coronet like a marquisat, and in what
they differ?
are the duties of man in society?
t are commanders of armies and fleets called?
wrote certain lines against war? and transcribe and
ent them.
is water forced to such great heights out of fire-en-
es?
w many days and years would a cannon-ball reach
sun, which is 96 millions of miles off?
army estimates for 1811 were 18,000,000 pounds
ling, how much is that per man?
what authority do the taxes originate?
commit accused persons to prison for trial?
is the whole of the projecting angle of a fortifica-
called?
... weigh 600 lbs., and he walk 4 miles an hour,
ding a momentum of 24 (4 × 6) how fast must a
... who weighs 200 lbs., to overpower and knock
n the horse?
is the triumph of mechanics?
is the valve of a pump, and how does it move?
is the inland trade of Great Britain carried on?
the eight principal points of the compass.
country encourages none but inland trade?
e are carpets chiefly manufactured, and how are they
e?
is a political constitution?
is the duty of a grand jury?
is a ship of the line?
are the names of the soldiers that serve on board of
it.

74 What is the sloping green bank called that surrounds a fortress?
75 What weight or height of quicksilver is equal to 33 ft of water?
76 What is the common law?
77 What was the origin of wars?
78 Who make laws in England?
79 What is the loadstone, and what are its uses?
80 What do the English import from France and Sweden?
81 Which now is the greatest trading nation in the world, and in what countries is its trade carried on?
82 In the highest wrought steel, what is the proportion between the value of the original metal and the labour bestowed?
83 How many pins can one person make a day by properly dividing the labour with others?
84 What is the origin of trade and commerce?
85 To what part of the world are fabrics transported?
86 How were the first countries divided?
87 Who command regiments?
88 How does the constitution of England secure liberty?
89 What are the nature and distinctions of property?
90 What is the principle of the construction of forts and castles?
91 What are the several ranks of officers in the navy?
92 How many merchant vessels are employed in the trade of Great Britain?
93 What are the manufactures of Sheffield, Paisley, and Worcester?
94 How many trades are required in the production of the Universal Preceptor?
95 How many valves are there in a pump, and where are they situated?
96 What are the prerogatives of the king?
97 What is the course of the law against a man who has committed a crime?
98 How to copy the accounts of parts
99 What are the titles of the heads of the church, the law, the navy, and army?

100 How can the earth be said to be round, when there are such high hills and great inequalities on its surface?
101 If an eclipse of the moon takes place at two in the morning, and by the almanac it ought to happen at London at half-past ten in the evening, in what longitude is the observer?
102 What is the character of the English territories in India?
103 What people consider train oil the greatest luxury?
104 On the days on which the sun passes vertical at Port Royal in Jamaica, i. e. in 18 degrees of north latitude, in what north latitude will it be uninterrupted day?
105 What are the causes of summer heat?
106 Who are the people whom the Europeans have been used to steal and sell for slaves?
107 What are the parts of an artificial globe?
108 Who discovered America, and when?
109 Which are the Asiatic seas?
110 How many human beings die on the average every minute?
111 How many *zones* are there, and point them out on the map?
112 Which is the *top* or *upper* part of the earth?
113 How many varieties are there of the human species? and let the pupil put his finger on the map towards the part of the world where each variety resides.
114 How many degrees of west longitude can there be, or in what degrees do east and west longitude meet?
115 What are the characters of the planets, and make them with the pen?
116 What is the relative situation of the moon when it is full?
117 What is the use of the moon?
118 How many continents are there on the globe?
119 Repeat Chatterton's lines describing the solar system.
120 Mark the characters of the signs of the zodiac, and repeat the stanza of six lines.
121 How do you prove that the stars apparently move from east to west?
122 How many moons are there in the solar system?

124 Are the fixed stars or the sun the farthest off, and what is the difference?
125 What is the natural food preferred by the Creator?
126 Which quarter of the world abounds in wild beasts, and why?
127 How many counties are there in England, Wales, Scotland, and Ireland?
128 Which are the most populous countries in Europe, Asia, Africa, and America?
129 Where is the sun vertical when it is equal day and night in every part of the world?
130 Repeat Young's lines on comets.
131 What are *asteroids*?
132 What is a cape, and what is a strait?
133 What are the names of the three stars in a row which thinson a winter's evening?
134 How much of the heavens can be seen at once?
135 What is the highest degree of latitude?
136 On which side of the earth is the moon during an eclipse of the sun?
137 What star is that in the heavens which always stands still?
138 How many tides are there in 24 hours, and what occasions them?
139 What occasions the blue colour of the heavens?
140 Why is man at the head of the animal creation?
141 Point out in the map the chief countries in Europe, enumerated at 321.
142 What are the names of the tropics, and how far are the tropical boundaries from each other?
143 What is the law of motion of the planets?
144 The shadow of what body occasions an eclipse of the moon, and what is its shape?
145 When did the English colonies in America declare themselves independant?
146 For what purpose is a fleur-de-lis put on a map?
147 What is the height of the highest mountains in the moon?
148 How far are the pointers asunder, and how far from the north-pole star?

What are the causes of day and night, and of winter and summer?

What are the distances of all the planets from the sun, and the period of their revolutions?

In what parts of the world did Captain Cook make his discoveries, and point them out on the maps?

N. B. Since these chapters were composed, Squire's Grammar of the Elements of Astronomy has been published, and merits the attention of every Student.

Questions on Chap. XV. XVI. XVII. XVIII.

Define the various species of sophistry.

What parts of a discourse are the exordium and peroration?

How many verbs and adverbs are there in the English language?

What Greek letters stand for *a*, *o* long, *o* short, and *ph*.?

What were the first and second parts of speech used by man?

What ceremonies distinguish the Quakers?

What is become of the descendants of Mahomet?

What is the name of that virtue which teaches humanity to all animals? and describe it.

What is the moral sense?

Recite Cowper's and Barbauld's lines on the Deity.

Define and give examples of the figures of rhetoric, called *irony* and *an illeism*.

What is the *fallacia accidentis*, and the *argumentum ad hominem*?

What is the cardinal rule of politeness?

What is the cardinal rule of composition?

N. B. The same author has been induced to edite a volume of *Models of Juvenile Letters on Familiar Subjects*; by copying which, he presumes young persons may soon become expert in the necessary art of elegant letter-writing.

What is the cardinal rule for the attainment of happiness?

170 What is a syllogism? and give an example
171 What are the best models of pure English s
172 What are the parts of grammar?
173 What is *analysis*, and what is *certainty*?
174 What are the respective objects of gramma
rletoric?
175 What is the religion of the Chinese and Hi
176 Did any separation take place among the
tians?
177 Describe the cardinal virtues.
178 Into what sects are the Protestants divided?
179 How many letters are there in the Greek
languages, and how many vowels in each
180 For what useful purpose is language divid
of speech?
181 What are the means of preserving the
guage?
182 What is the difference between conceiving o
prehensively and extensively?
183 Where is the history of Jesus Christ to be f
184 Give some examples of the present use of
hieroglyphics.
185 Copy out in Greek letters the names of the C
186 What are the means of improving in compo
187 Make the great and small Greek characters

What is the use of existence?
What is a syllogism, and what an argument?
What are the three rules of delivery?
I What is the chief rule for writing well?
) Transcribe the rules for thinking ably and correctly.
0 Who invented the letters, and what is their use?

Questions on Chap. XIX. *and* XX.

01 How many *genera* and *classes* of plants are there?
.02 What vegetables are of the greatest use to man, and what do they produce?
203 What are the classes which have the stamens and pistils on different flowers or plants, and how are they fructified?
204 What sort of air or gas do vegetables generate? and transcribe what relates to this subject.
205 What portion of nature has the sense of *feeling*, and what is feeling?
206 What insects create islands adapted for the habitation of man?
207 Describe the combs of a bee-hive.
208 How many cavities are there in the heart, what are they called, and how many times do they act in a minute?
209 How many senses have perfect animals, and describe them in prose and verse?
210 What are the use of bones, and how many are there in the human body?
211 What parts of the body can be traced to grass or vegetables?
212 What is the essential use of the different parts of the animal frame?
213 Repeat the rhymes on animalculæ.
214 How do insects respire?
215 What insect is supposed to occasion whitlows?
216 What are the principal distinctions of shells?
217 Do not some plants exhibit signs of irritability?
218 What are the elementary parts or substances of vegetables?
219 What are the means used by nature to scatter the seed of vegetables?

QUESTIONS TO THE

Repeat Blackmore's and Thomson's lines on the pl
ses of vegetation.
What are the nerves, and what are their uses?
What are the qualities that secure health, and why?
What is the peculiar contrivance of the Creator for
taining from motive beings, or animals?
What is the use of the leaves of vegetables?
What is a perennial, what a deciduous, what a tube
and what an indigenous plant?
What is the distinction use of arteries and veins?
How many teeth and ribs has a man or a woman?
In the circulation, when does the blood pass throug
lungs, and for what purpose?
What are the receiving, and what the expelling
of the heart?
What becomes of the blood after it has been rec
its appropriate cavity of the heart?
Explain the process of respiration.
How is the venous blood restored by nutriment
What weight of blood is there in a human b
how many strokes does the pulse give in a
Describe what is contained in the entire skin of
body?
How much does a human body perspire in 24
How often has the left ventricle of the heart
in a man of sixty five?
What is the food converted into before it is
the blood?
After the veins bring back the blood to the
of the heart, what becomes of it?
What are the lungs?
What is the use of the wax in the ear?
Repeat a description of the seven orders of
first class or monadia.
Repeat Hurdis's description of a bird's ne
What fills the bottom of the ocean?
Describe a wasp's nest.
How small were the insects seen by Lew
What are the properties of a polype?
What was Hunter's division of animal

248 Recite Pope's lines descriptive of the ascending scale of nature?
249 What are the orders of birds and fishes?
250 What are the respective effects of animals and vegetables on the soil?

Questions on Chaps. XXI. XXII. and XLIII.

251 When are the terminations *ous* and *ite* used?
252 What is the power of ascension of a spherical balloon 40 feet in diameter, the silk, netting, and car weighing 500 pounds?
253 What is nitrogen?
254 What is lightning?
255 What is the exact bearing and dip at this time of the magnetic needle at London?
256 What is supposed to be the cause of earthquakes?
257 Which are the chief volcanoes in Europe?
258 What is meant by a salt in chemistry?
259 What are the elements of all bodies, according to the moderns?
260 What is the choke-damp, and what the fire-damp of mines?
261 What is that acid which dissolves silver?
262 What is the acidifying principle, and how much is there of it, in 100 parts of atmospheric air?
263 How are mineral waters formed?
264 What is the name of the acid used in etching on glass?
265 How many different kinds of rocks are there?
266 What are the scientific names of *clay* and *flint*?
267 What is the peculiar property of phosphorus?
268 What is it that renders solids fluid, and fluids solid?
269 By what terminations are the strongest acids indicated?
270 What is that gas which is essential to animal life, and in what proportion is it necessary?
271 What is the use of the large glass cylinder which is made to turn round during electrical experiments?
272 What is meant by distilled water?
273 What does water become when it has been deprived of its caloric?
274 What is combined with those waters called chalybeate?

275 How is the presence of the electric power dis
276 How is the electric fluid known to be the sam
ning?
277 What is the electrical shock?
278 Is a glass cylinder necessary to the production
city?
279 What is meant by chemical combination?
280 Distinguish between *acids* and *alkalis*.
281 What rocks are those in which the remains
and vegetables are found?
282 What is meant by oxygenation, and what is pr
it?
283 What is that chemical agent which converts
blues into greens?
284 How is the electric fluid confined or prevented
fusing itself?
285 What is the object of chemical science?
286 What is effected by burning or combustion
287 What is the substance called pyrites?
288 How are Epsom salts formed?
289 Why does mortar become hard?
290 How is the electric fluid accumulated, so as t
electric shock?
291 What are the uses of alkalies?
292 How is the magnetic ore brought into the shap
dles?
293 Which are the principal volcanoes of Europe,
occasions their eruptions?
294 Repeat Thomson's lines on earthquakes.
295 What are the materials of an active galvanic ba
296 What is that that gives the brightness of champ
wines and water, and how is it detected?
297 How is the presence of arsenic in water discove
298 For what gas do some metals hurd spontaneous
299 What is the chemical name of common table s
300 What are the elements of the moderns, the sa
the antients being fire, earth, water, and air?

On Chap. XXIV.

301 How many sides are there in a square, a hexa
an octagon?

What is the object of trigonometry?
What is the hypothenuse and right angle of a triangle?
What is the proportion between the diameter and the circumference of a circle, and what part is the French metre of the distance from the equator to the north pole?
What are the uses of trigonometry?
What is the logarithm of ... and what is the natural number of the logarithm 5?
Make a large drawing of the trigonometrical projection of sines, co-sines, tangents, &c. &c. writing against each line its name.
What is the difference in calculation between superficial and solid contents?
What is the purpose of perspective?

Questions on Chap. XXV. XXVI. and XXVII.

What is the meaning of *a*, *b*, *c*, *d*, in algebra?
How do we ascertain the existence of light?
How many rays must proceed from every object in a second to render it visible?
What is the purpose effected by the arrangement of the glasses of a telescope?
What is a refracting telescope?
Which rays of light are turned the most out of their course by refraction?
How many shutters are there in a telegraph, and how many changes of signal will they effect?
In what do representations of phantasmagoria differ from those of the magic lanthorn?
What is the use of an air-pipe to a diving-bell?
What are those large massy clouds called that appear in the day-time?
What occasions noise in empty houses?
What occasions snow?
What is the primary ... kind?
Whence come the clou... a piece of wood
In verse, w... falls qu...

pupil of the eye, and reverse the image on the retina, how is it that we see them upright?

325 What is the large glass of a telescope called?

327 Do near-sighted persons require convex or concave spectacles?

328 What is the chrystalline humour of the eye?

329 What is refraction?

330 How do we ascertain the wonderful velocity of light?

331 Read $a + b - c$.

332 If a is equal to 8, b to 5, and c to 4, what is the value of $ab + c - a$?

333 If a is equal to 7, b to 9, and c to 12, what is the value of $bc + bc - c^2$?

334 Read $ab + x - xac = cb - \sqrt{y}\ x$.

335 How is a fluxion expressed, and give an example

336 What use has been made of hydrogen gas?

337 What is the cause of the ignis fatuus, or will-o'-the-wisp.

338 Do stones ever fall from the clouds?

339 What is the cause of hail?

340 How fast does the wind blow in a storm?

341 What degree of the thermometer is called the freezing point?

342 What is the annual average depth of rain in Great Britain?

343 What becomes of the water after it falls from the clouds?

344 What are the hottest months in Great Britain?

345 What degree of heat will Wedgwood's Pyrometer measure?

346 What are the distinct purposes of barometers and thermometers?

347 Make a drawing of a telegraph.

348 What are the relative properties of white and black?

349 Repeat Blackmore's lines on the prismatic colours, and draw in large the experiment of the prism, colouring the divisions.

350 What would the consequence be if there was no light?

351 How much larger will a man appear at two yards distance than at twenty?

352 What is a Galilean telescope?

353 Get two spectacle-glasses, of different convexities, at any

optician's, and make the experiments described at page 269.

What is the purpose of all the humours of the eye?
What is the cornea?
What is reflection?
In old people, do the rays converge too far or too near?
What is the cause of rainbows?
At what height is the atmospheric air dense enough to reflect rays of light?
What depth of water evaporates or ascends as vapour from water per annum, and what from land?
How many solid miles of water fall per annum on the land only?
Repeat Thomson's lines on the origin of springs.
What is the principal cause of terrestrial heat?
What might be effected by high metallic conductors?
In what parts of the world do the winds blow always in the same direction?
What is thunder?
What is the difference between the average temperature of Great Britain and of the equator?
What are the prevailing winds in Great Britain?
What is the difference between the average depth of rain in Great Britain and between the tropics?
What is the purpose of an air-pump?
Dissect with a pair of pointed scissars a sheep's eye.
Draw the figure of a rainbow, and the progress of the rays, as at page 269, on a scale two or three times the size, colouring the rays and circles.
Why are there three lenses in the eye-piece of a telescope?
What is the magnifying power of a telescope, of which the focal distance of the object-glass is three feet, and of the eye-glass a quarter of an inch?
What is the purpose of a concave lens?

Chapters XXVIII. *and* XXIX.

What are the aerial vibrations like that produce sound?
How rapid are the vibrations of sound?
What is the relative velocity of sound and light?

[illegible] How do stringed instruments produce sound?
380 How do wind-instruments, as the wind pipe of men and animals, and tubed instruments, produce their effect?
381 What is the concord of sounds?
382 What is an octave?
383 What is harmony?
384 How is extension known to be infinite?
385 Why is sugar sweet, and vinegar sour?
386 Is motion natural to matter?
387 How is the property of infinite divisibility proved?
388 What is weight?
389 What are Sir Isaac Newton's and Sir Richard Phillips's opinions respectively on attraction?
390 What are the primary laws of motion?
391 What is meant by accelerated motion of aggregates and of atoms?

On Chapter [illegible].

392 How arose the division of the year into months?
393 Why is the second day of the week called *Tuesday*, and by the Romans *Martis*, and why is the second month of the year called February?
394 What was the distance of time from the death of Charlemagne to the accession of Napoleon Buonaparte?
395 Turn the date of the death of Richard III. into a final syllable.
396 What were the names of the four great monarchies or empires of antiquity?
397 Who conquered France?
398 What king of England was beheaded, and when?
399 What were the Roman names of the English counties?
400 Who were the great characters distinguished in Grecian history?
401 Who were the great characters distinguished in Roman history?
402 Who were the founders of the four great monarchies?
403 What length of pendulum vibrates in a second of time?
404 In what precise time does the earth return again to the same point of its orbit in revolving round the sun?
405 In how many years will the exact excess above 365 days

(reckoned as a year) make an even number of days, or bring the reckoning and time equal?

What month is called after *Juno*, and what day after *Frigga*?

What day of the week answers to *Jovis*, *Solis*, and *Veneris*?

What is meant by leap-year?

How often must a leap-year be omitted to allow for the 11 minutes 3 seconds gained every year by taking a leap-year every four years?

Make words for the date of the destruction of Carthage, and the defeat of the Spanish Armada.

Is history to be relied upon?

What was the origin of empires?

What were the ancient names of Italy, France, the Netherlands, and Spain?

What were the modern names of Mesopotamia, Thule, Parthia, Numidia, Epirus, and Latium.

What have been the great events in English history?

What were the great events of Grecian and Roman history?

N. B.—For the accurate study of History, the Student should go through Robinson's Grammar, reading, at the same time, his Ancient and Modern Histories.

On Chapters XXXI. XXXII. *and* XXXIII.

Which were the superior gods in the Grecian mythology?

Who were the Fates, the Furies, and the Graces?

Who was Sinna, and who was Odin or Woden?

What is the point of sight in a perspective drawing?

What have been the great schools of painting?

Of what schools were Rembrandt, Reynolds, Rubens, and Raphael?

Draw those heraldic characters which signify the second son, the fifth son, and the sixth son.

In coats of arms, what signify dots; what lines from top to bottom; and what are the nine points of an escutcheon?

What was the origin and purpose of coats of arms?

What are the distinctive characters of the *hatchments*, put in front of houses after death?

427 What is the ground plane, and what the perspective
428 What is the object of perspective drawing?
429 What should be the order of practice in [illegible]
[illegible]
430 Who were Morpheus, Jupiter, Bacchus, Charc
Bellona, among the Grecian divinities?
431 Who were the chief personages of the Persian, H
Egyptian, and northern mythologies?
432 What are the requisites of a great painter?
433 Of what schools were those famous painters, T
Corregio, Claude, Holbein, Gainsborough, H
and Berghem?
434 What do beasts and their postures signify in the
of coats of arms?
435 How is the third son of a second son [illegible]
436 Who was the god of riches, who of the [illegible]
and who was the father of the Nine Muses?
437 Who was the god of the ocean, the god of war, th
dess of wisdom, and of fertility?
438 How is the fourth son of the third house [illegible]
439 What is relief, and how should shadows fall?
440 What means a death's head on an hatchment?
441 Under what shapes were the Egyptian divinitie
shipped?

Questions on Chapter XXXIV.

442 How many kinds of poetry are there, and describe
443 Who was the prince of poets, and who has follo
his line?
444 Who were the dramatic poets of Greece and Rom
445 Who have been the poets of Italy and France?
446 Who have been the famous prose writers of Spai
who the great mathematicians of England?
447 Who are the historians of Rome and England?
448 What is Iambic verse? and give an example.
449 What is the effect of the *accural* pause, in differen
ations?
450 What is the name of that verse in which the accent
every third syllable? and give an example.
451 What are the features of English versification?
452 Whose is the best translation of Homer, Homer
Virgil?

In what line of writing was Tacitus, Locke, Priestley, Blackstone, and Hume?
What societies have we in England to promote learning and literature?
Who have been the chief historians and Roman writers in the English language?
What are the names of the chief epic poems?
Who have been the chief poets of Italy, France, and England?
In what department of literature have Churchill, Clarendon, Cunningham, Young, Cowper, Watts, Paley, Defoe, and Burke, been chiefly distinguished?
What is the object of literary societies?
What are the chief divisions of poetical and prose compositions?

Miscellaneous Questions.

How many boys and girls are there in England and Wales between 6 and 14 years of age, supposing they form one-sixth of the whole population, and are in equal numbers?
Make a drawing on a large scale of the parts of a fortification, and write their names against the several parts.
Describe the second order of each class of animated nature.
Extract and cast up into one total the population of all the countries in the world, and add one hundred millions for the unarranged or unclassed parts, chiefly in Africa, America, West Indies, and South Seas.—*Total 784 Millions.*
What proportion is the English yard of the distance from the equator to the north pole?
When was America discovered, by whom, and what were the consequences of the discovery?
What nation avoids killing and eating living animals, and profess vegetables and fruit?
What are the different descriptions of property in England?
How is thread prepared for the weaver?

470 What are the materials of which houses are built?
471 Point out on the print of the solar system the circles or orbits of each of the planets, and name them.
472 Write out neatly the characters or hieroglyphics which stand for the planets and the signs of the zodiac.
473 How many degrees is it from the ant-arctic circle to the tropic of cancer?
474 The stars on the celestial globe being expressed by the first letter of the Greek alphabet, write out the first ten of the small letters, and call them backward and forward?
475 Transcribe a description of the animal which is at the head of the creation?
476 What are the principal breeds of oxen and sheep?
477 Are wheat, potatoes, acorns, apples, and blackberries, natives of Great Britain?
478 What is effected by lifting up the handle of a pump, and what by pulling it down again?—Transcribe and repeat.
479 How many degrees is it from the Pleiades to the belt of Orion, and how far from the belt of Orion to the north pole star?
480 If the pupil has learned to draw, let him copy one of the cuts per day, at pages 119, 123, 124, and 128, and write out their descriptions.
481 What are the attributes of God?—Transcribe and repeat.
482 What is the moral sense?
483 What is effected by the constitution of England?—Repeat.
484 Describe the gradations of animated nature.—Transcribe and repeat.
485 What are the component parts of air and water?
486 Draw the representation of the planet Saturn.
487 What did Julius Cæsar effect for the English?—Transcribe and repeat.
488 What are the advantages of society?
489 What is the general rule in regard to the rotation of crops?
490 How many teeth has a man, and how many species of insects are there?

What classes of plants are those in which there are nine stamens, in which the stamens and pistils are invisible, and what are the vegetables of the greatest value to man?

How can you demonstrate the motion of the moon?

How many oceans and continents are there, and what are their names?

What is beneath our feet towards the centre of the globe?

What seems to be the proper object of vegetables?—Repeat.

What is the distance in miles of the arctic and antartic circle?

How are sailors able to tell where they are by the celestial bodies?

Describe the different species of sophistical arguments?

How many kinds of shells are there?

Where are the West Indies, and what are they?

What are the names of the great rivers in Asia? and point out each of them as are laid down on the map.

What familiar object is the motion of the earth like?

Draw the phases of the moon when she is on either side of the earth, and in the midway between her conjunction with, and opposition to the sun.

How much of the earth does the sun illumine, at one time?

What will children learn from viewing insects through a microscope? and repeat any appropriate lines.

Which religious sects are those that deny the authority of bishops, and preach extemporaneously?

In what parts of the world are the inhabitants of pigmy, and in what of gigantic stature, and what are their proportions?

Where are the largest lakes in the world, and is there any thing remarkable near them?

Write out Paul's oration before Agrippa (Acts, chap. xxiv.) and distinguish its rhetorical parts by placing their names before each.

Copy out the song of Moses, Exodus xv. and distinguish by words the figures of rhetoric as you proceed.

511 Transcribe and repeat the different branches of the study of language, and describe them.

512 Transcribe the five rules of conception.

513 What are the means of attaining knowledge?

514 What are the prevailing religions in the world?

515 What are the habits of ants?

516 Continue the series of logarithms at 505, from 6 to 7, 8, 9, and 10. Shew also that the logarithms of 2, or 1 and 8 added together, are equal to the product of the numbers corresponding with 1 and 8.

517 Who has the power of pardoning criminals in England after the sentence of the law has been passed on them?

518 What are the obligations of man in society?

519 What is a polygon?

520 How many inhabitants of one city did the last eruption of Mount Etna destroy?

521 Make out an account of earths as they exist in layers, and as they are chemically considered; also of minerals of the four classes, and of rocks as they are divided into five classes, the whole forming a complete view of the mass of the earth.

522 Trace the map of the world on thin paper, or copy it as neatly as possible, as a certain means of being perfect in geography.

523 Describe the silk manufactory and silk worms; and draw the eggs, the worm, the chrysalis, and butterfly, given at page 200.

524 Whence come sugar, oil, and Indian rubber?

525 Briefly describe the animal senses in verse and prose.

526 How are plants nourished?

527 How are animals nourished?

N. B. The answers to the two preceding questions must be combined, and be full and complete.

528 How is it that the perpendicular rays of the sun do not dissolve the snow on the tops of the mountains under the equator?

529 What poet describes so accurately the revolutions of day and night, and of the seasons?

530 Trow by experiment in the sun, or before a fire or candle, the cause of increased heat at different seasons.

31 Give some instances of the subdivision of labour, and of the utility of it.
32 Transcribe a description of the ship, its apparatus, &c.
33 What is the fundamental principle of the mechanical powers?
34 What is the fundamental principle of trade?
35 What is the essential difference between vegetables and animals?
36 When is war necessary?
37 What was the origin of architecture?
38 Name the different species of grain and grasses cultivated by English farmers, and mention the use of inclosures.
39 What was the origin of money?
40 Enumerate the various ranks of peers, of the church, of the law, and of the army and navy.
41 What in general remains when any part of the air is deprived of its oxygen?
42 On what principle is trigonometry founded?
43 What are the three principal contrivances by which varied melody is given to sound?
44 Copy the map of the world, and substitute the ancient names in 653 for the modern ones now in the map as far as given.
45 Write out the names of the painters of the great schools in parallel columns, with heads distinguishing the schools.
46 Write out the illustrious names in history, under the heads of their respective countries.
47 Write out, under the heads of their respective countries, the names of great authors, poets, &c.; distinguishing by subheads their walks in literature, when so distinguished in the work.
48 How long was it from the building of Rome to the death of Cæsar, and from the battle of Marathon to the battle of Marengo?
49 If a string is 120 parts, and its octave 60, with the intermediate parts of lengths as indicated in 621, and 622, what will be the length of an octave higher than that of 60, and of its intermediate notes?
50 Read $a\,x+x^{\cdot}-6y=c+y^{2}-\sqrt{a}$.

551 What is the circumference of a grass plot whose diameter is 88 yards, and what relation does it bear to an acre?
552 How does the constitution of England secure liberty and good government; and where are the public rights of the people recorded?
553 How many kinds of law are there?
554 How were sea voyages performed before the invention of the compass?
555 How many merchant vessels are employed in the trade of Great Britain, what is the annual value of the exports and imports, and how many people does its trade employ?
556 Describe the triumph of mechanics.
557 How was light let into houses before the composition of flint and soda?
558 What is a square, a triangle, an ellipse, a diagonal, a tangent, a sine, a co-sine, and a hexagon?
559 Repeat Mallet's description of a volcano.
560 Repeat Thomson's description of an ignis fatuus.
561 Illustrate the terms used in chemical processes.
562 Put some small pieces of paper in motion by electricity
563 Repeat Cowper's lines on flowers.
564 How many kinds of arguments are there?
565 Repeat Thomson's lines on bees.
566 Describe the principal earths.
567 What is the process of filling a balloon?
568 What are the mineral waters, and how are their kinds ascertained?
569 Describe some of the characteristics of animalcules.
570 Describe that animal which is not killed but multiplied by being cut to pieces.
571 Shew the vibrations of sound by experiment.
572 What membrane vibrates in the throat in speaking or singing?
573 When was the style altered, and how many days had then been gained in reckoning?
574 Which months have numbers for their derivation, which the gods, which men, and which a corresponding term?

5 Range in three columns the English days of the week, their derivation, and the Roman names.
6 Under what names was Jupiter known to different ancient nations?
7 How many kinds of mathematical sciences are there?
8 What will occasion, and what will destroy polarity?
9 Make a microscope without glass.
0 What are the names and purposes of the various instruments for observing variations in the weather?
1 Describe the causes of winds, clouds, hail, rain, snow, and dew.
2 What is an echo?
3 What do botanists call fruit, and what is the object of fruit?
4 Describe the most populous nation of Asia.
5 Shew by experiment the causes of the different lengths of day and night.
6 How is the distance of the sun, moon, and planets calculated?
7 What is the angle of the plane of the earth's equator to the plane of the elliptic?
8 How many trades are requisite to build and furnish a house?
9 Describe the moon.
0 Describe the fixed stars.
1 Describe the sun.
2 Describe the earth.
3 Draw a solar system extending to Saturn in such proportion, that the distance of Mercury be taken at half an inch.
4 If a man has robbed me on the highway, how am I to proceed against him by the laws of England?
5 How many different measures of versification are there?
6 Which is the largest, the ale or the wine gallon, and how many cubic inches are there in a pint of each; and if a pint weigh a pound, how much does a hogshead of each weigh?
7 What is the numerical value of

$$7a+\frac{b}{a}-c^2+abc-cd^2;$$ a being equal to 8 b to 16; c to 6; and d to 10.

N. B.—The pupil must add all the + together, and all the — together, and then subtract the latter from the former. The difference will be the value.

598 To what faculty is man indebted for his improvements?
599 Describe all the metals.
600 Describe the varieties of the human species.
601 Make a formal syllogism, to prove that study is the proper employment of youth.
602 By the scale of mountains, on the maps, page 116, which appears to be highest, the peak of Teneriffe or Mont Blanc; and the city of Quito or Snowdon, and what are the differences?
603 How often must Snowdon be piled on Snowdon to make a Mont Blanc or a Chimborago?
604 Point on the maps to London, Jamaica, Calcutta, Philadelphia, Pekin, and Jerusalem.
605 Name all the countries between the tropics, in each hemisphere.
606 Name all the countries in the north temperate zone.
607 Point out the orbits of the *Asteroids*, or hemispherical planets, in the plate of the universe.
608 What is the name of that planet accompanied by seven moons, and of that by six moons?
609 Point out the orbits of the comets.
610 How many planets, asteroids, moons, and comets, are represented in the plate?

Answers, or references for answers, are to be found in THE TUTOR'S KEY

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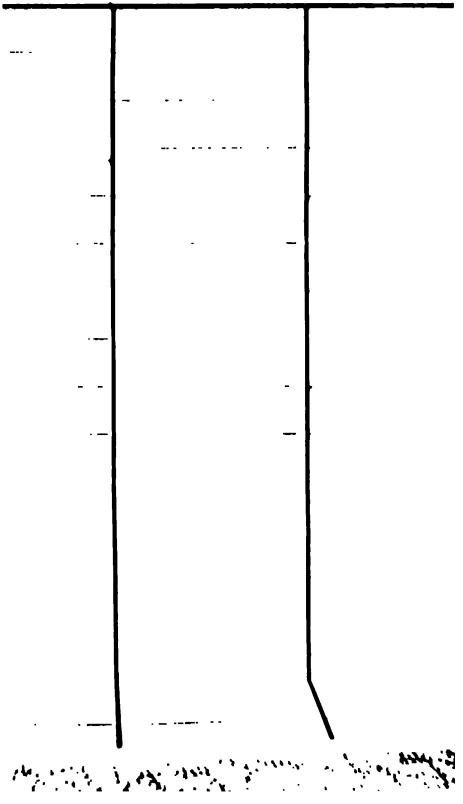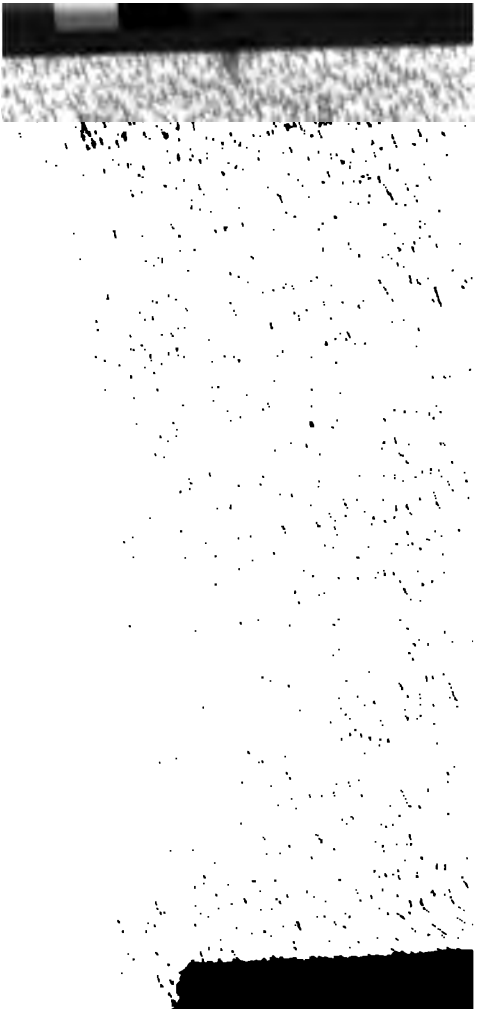
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